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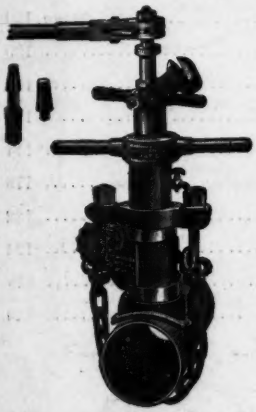

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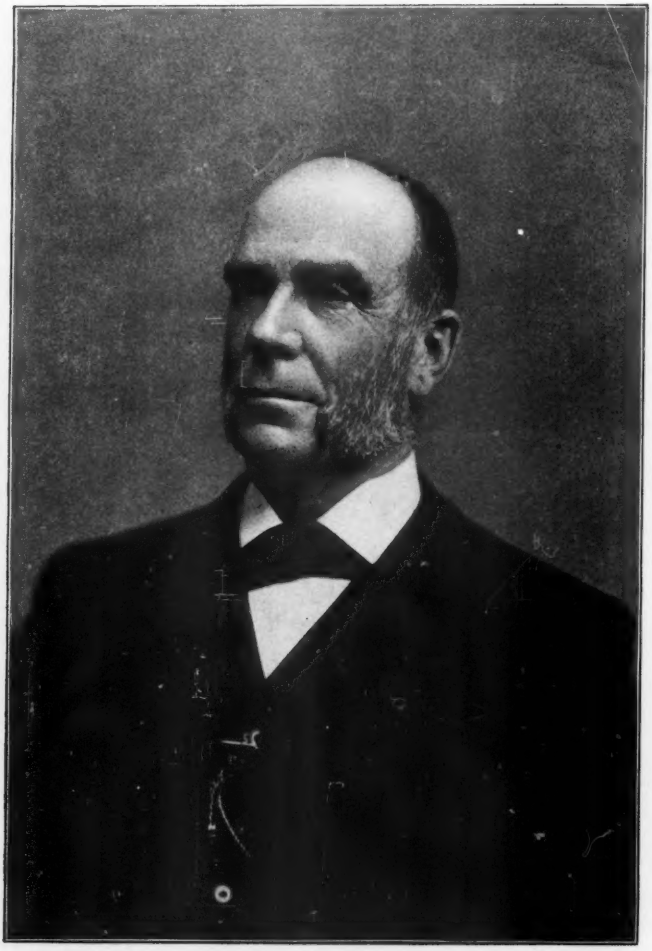

CHARLES K. WALKER,
President of the New England Water Works Association,
1903.

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*This Association, as a body, is not responsible for the statements or opinions of any of its members.*

# REMOVAL OF COLOR, ORGANISMS, AND ODOR FROM WATER.

BY H. W. CLARK, CHEMIST OF THE MASSACHUSETTS STATE BOARD OF HEALTH.

[*Read September 11, 1902.*]

A very large amount of work has been done in this country during the last ten or twelve years, investigating the purification of water by sand filtration. A large part of this work has been directed to the study of efficient methods of removing bacteria from water, although in some instances the removal of clay, silt, etc., causing the water to have an objectionable turbidity, has been studied in connection with bacterial purification. It is my purpose in the present paper to describe briefly some filtration experiments, the main object of which was the removal from water of coloring matter, odors, and the organisms producing odors.

## COLOR.

In all the experiments at the Lawrence Experiment Station of the State Board of Health upon the purification of water, the colors of the water applied to and of the effluents from the sand filters in operation there have been recorded. This color determination during the past twelve years has been made with Hazen's platinum standard.

The two largest experimental water filters at Lawrence, and the two that have been operated for the longest period, are known as Filters Nos. 3B and 8A. They were started in 1893, and contained at that time 5 feet in depth of sand, of an effective size of 0.24 millimeter. At the end of 1900 their depth was approximately one half as great as at the beginning of their operation. The average rate of filtration for the entire period of Filter No. 3B was about 2 500 000 gallons per acre per day, and that of Filter No. 8A

about 3 000 000 gallons per acre per day, although the rates varied considerably during the seven years. Both filters removed approximately 33 per cent. of the coloring matter in the water applied to them, although their efficiency varied considerably during different years and different periods of the same year.

Up to the year 1899 nearly all the work upon color removal at Lawrence had been simply incidental to other work and had been carried on with Merrimac River water only, from which, as I have stated, practically 33 per cent. of the coloring matter can, on an average, be removed by sand filtration. During 1899, however, some further experiments were begun. A large tank, holding some 8 000 or 9 000 gallons, was filled with the river water, and the color of this water was increased and varied by adding to it decaying vegetation of different kinds and in different amounts, as much water being run into the tank each day as was drawn from it for our filters. This work was of only slight importance during 1899, but was continued during 1900 and 1901, and the water in the colored water tank passed through many different phases during these years. Its color was increased, until during considerable periods it was several times as great as the color of the river water, and the nature of the materials added to produce this color caused the water to be at times, during the warm weather, in a state of fermentation, while at other times it was in a condition of equilibrium; that is, it would hold oxygen in solution instead of immediately using it.

A number of sand filters were operated, to which this highly colored water was applied, several of these filters receiving the water without preliminary treatment with chemicals, etc., while the water applied to others was first treated with chemicals of different kinds. By sand filtration alone we removed from 60 to 80 per cent. of the color of the applied water, month by month, when filtering at rates of from 1 000 000 to 2 500 000 gallons per acre per day, or an amount two and one-half times as great as is ordinarily removed from the Merrimac River water by filtration. It was quite noticeable, moreover, that the coloring matter in the water was more easily removed when the water obtained its color from old and decaying organic matter than when the color in the water was taken from fresher organic matter. It was also noticeable that the more active the state of fermentation in the tank containing the colored water, — that is, the more nearly the dissolved oxygen was exhausted, — the more completely could this water be decolorized by sand filtration,

if enough oxygen was introduced by aëration before filtration to last while the water was passing through the filter; that is, it was apparent that the intensity of the bacterial action in the tank of colored water had considerable to do in decreasing the amount of work to be performed by the bacteria in the filter.

These filters receiving Merrimac River water rendered highly colored by infusions of peat, hay, etc., not only removed a very much larger percentage of the coloring matter of the water than did the filters operated during the same period with untreated river water, but in many instances the color left in the water was less than the amount left in the effluents of the filters receiving river water. This seemed to indicate that not only the coloring matter added to the Merrimac River water by the decaying organic matter in the tank, but also the coloring matter primarily in that water when passing into the tank, was more easily acted upon and removed by filtration, after undergoing the fermentation active in the tank water during warm weather.

By the addition of alum or ferric chloride to the water, followed by filtration, practically all the coloring matter was removed, but it was necessary in some instances to add lime in order to aid in decomposing the amount of alum necessary to remove the coloring matter; that is, the alkalinity of the water was not sufficient. Various other chemical treatments were experimented with, especially potassium permanganate, this salt giving at times excellent results, but at others its entire reduction and precipitation were attended with considerable difficulty. When this occurred the color of the filtered water was increased instead of diminished.

Beginning in December, 1900, and extending until the end of January, 1902, a period of slightly more than thirteen months, experiments were carried on upon the removal of color, odor, and organisms from the Ludlow Reservoir water and the water from the canal which enters this reservoir. The reservoir and canal water are the chief supplies of the city of Springfield, in this state. This investigation was the joint work of the city of Springfield and the State Board of Health, and the method of experiment, the number and variety of filters, and the laboratory work were under my charge.

Ludlow Reservoir has an area of 445 acres, with an average depth of 13.7 feet, and its bottom is largely covered with a deposit of mud of considerable depth. The water from this reservoir has often caused considerable trouble to the city of Springfield, as enormous number

of microscopical organisms grow in it during the summer and impart tastes and odors to its waters. In this reservoir we seem to have on a large scale conditions somewhat similar to those prevailing in our tank of water at the experiment station just described, where mud, peat, decaying wood, etc., were used to add color and organic matter to water for experimental filtration. In the reservoir, with its muddy bottom, its decaying tree stumps, etc., there is in the warm weather not only a growth of anabæna and other organisms, but also a decided increase in the color of the water, and practically all of this coloring matter is in solution.

The average color of the water in the reservoir during the first six months of the year of investigation was about .40. During the last part of July it increased rapidly, and during August the average color was .64, varying on different days and reaching as high a point as .86. During September the average color was .57, and during the remaining months of the year about half of this.

There were eight filters receiving this water, the principal ones being known as Filter A–B, Filter C, and Filter G. These filters each contained five feet in depth of sand of an effective size of 0.28 millimeter, and with a uniformity coefficient of 3.2. Filter A–B was operated at a rate slightly greater than 2 500 000 gallons per acre daily, Filter C at a rate of 5 000 000 gallons per acre daily, and Filter G received the effluent of Filter A–B at a rate of 10 000 000 gallons per acre daily.

Filter A–B, operating at a 2½ million rate, removed during the first three months of the year, when the water in the reservoir had an average color of .41, 17 per cent. of this color; during April, May, and June its efficiency increased and it removed 32 per cent.; during July, August, and September, when the color of the reservoir water was high, it removed 63 per cent.; and during the remainder of the year 40 per cent. That is, during the four months of the year when the reservoir water had the highest color, the effluent of this filter averaged as low or lower in color than during the months of the year when the reservoir water had the least color. The result was due to a number of causes: The increased temperature enlivened bacterial oxidation in the filter, which caused a considerable increase in color removal; the color removal was large also because of the nature of the coloring matter in the reservoir water, which was absorbed from the decaying organic matter during the period of fermentation, so to speak, in the reservoir; that is, a

combination of high temperature, scarcity of free oxygen in the water, and undoubtedly its entire absence in some places, together with a bacterial activity which rendered this organic coloring matter easily oxidized in the filters, all helped in giving good color removal.

The filter receiving the water at a rate of 5 000 000 gallons per acre daily removed nearly as high a percentage of coloring matter as the one just described, operating at half that rate.

Filter G, receiving the effluent of Filter A–B and operating at a rate of 10 000 000 gallons per acre daily, removed about 30 per cent. of the color of the applied water; that is, during the five months of the year when the color of the reservoir water was highest, averaging during two of these months .64 and .57, and during many days and weeks of this period being even higher in color, the color removal by sand filtration at rates of 2 500 000 and 5 000 000 gallons per acre daily was 63 per cent. and by double filtration 75 per cent., giving a final effluent with a color of .13.

Filters of the same construction as these already described were operated with the water of the canal which enters the reservoir. This water, although largely from swampy sources, apparently contained organic matter in a more stable condition than that in the reservoir water. During several months of the year, however, approximately 50 per cent. of the coloring matter of this water was removed by the filters; that is to say, sand filtration, unaided by chemicals, both at Lawrence and at Springfield, removed approximately 75 per cent. of the coloring matter from highly colored waters when this organic coloring matter was taken from decaying vegetable matter and when it was in a state of unstable equilibrium, so to speak. With the organic matter in water in a more stable condition, however, as is the case in the Merrimac River water when it is the most highly colored, only from 20 to 35 per cent. of the coloring matter can be removed by sand filtration.

### REMOVAL OF ODOR.

The odors of the waters which we have experimented with have been caused either by the absorption of the characteristic odor of growing vegetation, or by the decay of vegetation, or have been imparted to the water by the life and death of microscopic organisms. The odors present in the Merrimac River, which is at the present time badly polluted by domestic and manufactural sewage, are easily removed by sand filters when operated at a very high rate. The

filters operated at Lawrence during the past three years, receiving water treated with vegetable matter in order to increase its color, etc., have almost universally removed all the odors, often strong, imparted to this water by the decaying matter which we have placed in it.

In the Lawrence experiments we undertook to cause the growth of organisms in our colored water supply tank, but the only one which appeared there in any numbers, and which causes odors in water, was asterionella. The odor caused by this organism appeared to be quite prominent at times in this water, and the filters invariably removed a very large percentage of it. Ludlow Reservoir water, however, is one which at times, for many years, has caused serious trouble to its consumers because of the growth within it of anabæna, uroglena, etc., and this was the case during a considerable portion of the period of investigation at Ludlow.

We made daily microscopical examinations of this water from the beginning of February, 1901, until the end of January, 1902, and the water passed through many phases of microscopical growths in this period. During February the numbers of organisms present upon different days varied from 200 to nearly 900 per cubic centimeter, and dinobryon was present in considerable numbers. During March the daily number of organisms varied from 436 to 3 700 per cubic centimeter, being about equally divided between asterionella, dinobryon, and zoöspores. During April the number of organisms was considerably less, the highest number present being 656 per cubic centimeter, the larger number of these being asterionella. During the first part of May the condition of the water was about the same in this respect as during April, but beginning May 13 the number of asterionella present began to increase very rapidly, and large numbers were found from that date until June 18, the greatest number being found during the last week of May, when nearly 8 000 asterionella per cubic centimeter were present. During this month synura and uroglena were also found several times. From the last part of June until the middle of July but few organisms were present in the water, but beginning July 12 anabæna began to be found, and it increased rapidly in numbers until it reached a maximum of 5 600 per cubic centimeter upon August 7, very few other organisms being found at this time except a few asterionella. From August 8 until August 16 anabæna was only once found in numbers greater than 2 000 per cubic centimeter, but beginning on the latter date

there was a period of a few days when much larger numbers were present, the greatest number on any day being about 11 000 per cubic centimeter. From this time it was uniformly present in the water in comparatively large numbers until the middle of September, when it grew rapidly less, and practically disappeared from the reservoir by September 25.

The odor of the reservoir water followed to a large extent its microscopic condition. During the first part of 1901 the odor was only very faint, and was designated as vegetable. Through the last part of February and lasting until about the first week in April, the odor of dinobryon was noted frequently in the water, and during April and a portion of May the aromatic odor due to asterionella was detected, especially when the water was heated. During June the odor of the water was designated as either fishy or aromatic when cold, and decidedly grassy when heated. At the beginning of July the grassy odor due to anabæna began to be very prominent, and this odor increased very materially, until the water had an exceedingly strong, disagreeable, grassy odor, due to anabæna, both when cold and when heated, and this condition lasted for two months, that is, until the 24th of September, the strongest odors occurring from about the 20th of July until the end of August. During this period the odor, not only of the water but at times of the air around the experiment station, was very strong, and the growth of anabæna in the reservoir formed a thick layer along one shore, reaching out 40 or 50 feet into the water.

Filter A–B and Filter C, receiving this reservoir water at the rates of 2 500 000 and 5 000 000 gallons per acre per day, as already stated, removed practically all the odor of the applied water until the middle of July; that is to say, none of the fishy odors that might have been expected owing to the presence of large numbers of dinobryon in the reservoir water, and only a very slight trace of the aromatic odor due to asterionella in the reservoir water, were noted during the early months of experiment. During the period when anabæna was present in the water, however, and the water had a very strong odor on this account, this odor persisted in the water during its passage through the filter, and was present in the effluent of each of these filters, but to a considerably less degree than in the reservoir water. Filter G, however, to which the effluent of Filter A–B was applied at a rate of 10 000 000 gallons per acre per day, was operated throughout this period of strong odors and pro-

duced an effluent entirely odorless, except at times when just collected from the outlet pipe of the filter; the odor at that time being so faint that its character could not be determined easily, and not having at all the odor of the anabæna in the applied water.

Filter C removed all organisms from the reservoir water, although Filter A–B for several weeks, beginning August 21, allowed anabæna to pass through; this evidently being due to some untoward disturbance of the surface sand of the filter.

The effluent of Filter G, receiving the effluent of Filter A–B, was free from organisms throughout its period of operation. By double filtration of Ludlow Reservoir water, even when containing an enormous number of organisms which produce odors, and having the characteristic odor of these organisms to an exceedingly marked degree, we removed not only all the organisms, but all the odors produced by them; that is, practically all odors caused by the enormous growths of asterionella and dinobryon in the reservoir water were removed by single filtration, and by double filtration all odors due to an enormous growth of anabæna were removed.

During the present year I have had a slight experience with filtration of a water containing large numbers of uroglena, and I am confident that this odor, even when very marked, can also be removed by sand filtration.

The water in the canal entering Ludlow Reservoir during this period had a very much smaller number of organisms than did the reservoir water, the odor of the water was very much less marked, and the filters receiving this water removed practically all the odor of the applied water.

# DUTIES OF MUNICIPALITIES REGARDING WATER SUPPLY.

BY HON. J. O. HALL, QUINCY, MASS.

[*Read September 10, 1902.*]

*Members and Friends of the New England Water Works Association*, — It may seem presuming in one who has had no opportunity to deal directly with the real problems and difficulties which attend the business of securing water for and distributing it to a community to present a paper for the consideration of a body of men so practical and experienced as this, and I assure you I approach the duty with a great deal of trepidation.

The ability to secure an adequate and proper supply of pure water at the lowest possible cost to a community exists only in those of broad and varied attainments, ripened by extended and careful study.

The source of supply having been secured, much tact and constant watchfulness are required to protect it, that its purity may not be contaminated.

To properly and economically distribute the supply throughout the community is another and a separate problem, and to so forecast and plan this system of distribution that it shall meet the ever-increasing needs of the community with the minimum of cost for the substitution of larger waterways for those at first provided requires abilities of no mean order.

To watch the finances of such a system of supply and consumption, so that the management and construction may be economical and efficient, and the revenue religiously and satisfactorily collected, requires faithful and conscientious service not exceeded by any department of the public business.

In view of the ability required for the efficient care and administration of a system of water supply, which ability is so strongly shown by the members of this Association, do you wonder that I hesitate in offering a paper for your consideration?

There are, however, so many sides to the purposes and projects, to the duties and responsibilities of this special department of the

public service, that possibly I may be able to add something of interest or profit to the exercises of the passing hour. In a certain sense I may stand in the attitude of a theorist, not having been engaged intimately in handling the duties and difficulties which daily confront you, but the relations between the theorist and the practicalist may be strongly marked and yet both may exist in one person. There is the speculative theorist who is forever at work upon problems of research either in science or in sociology, and who is continually striking out the sparks which kindle in the brain of the practicalist those fires which give great results for the welfare and for the advancement of the human family. The theorist dwells in a different atmosphere from and is often the object of the strongest disapproval of the practicalist, yet both are needed and both have been equally the benefactors of the race.

The practicalist reaches the accomplishment of his purpose by feeling his way along step by step in action, while the practical theorist goes straight to his point by a way well thought out from the beginning, and by methods previously provided overcomes the difficulties which have been seen from that beginning.

Of all the many and varied lines involved in ministering to the needs and to the welfare of a community, none exceeds in importance that of furnishing an ample supply of pure water, and none demands more strongly the attention of the practical theorist. It may be claimed that water is a dry subject, but I do not think it so. We hear all sorts of ridicule regarding its value and uses, and its unpopularity except for the purposes of the toilet and the laundry, and many maintain that a little of it mixed with something of a stronger nature is the only reason for its existence. Notwithstanding all this, however, a water supply has been from time immemorial a subject for thought and careful preparation.

The patriarch built his well and carefully guarded its treasures and its surroundings, allowing only his family or his tribe or some favored ones, for generation after generation, to partake of its waters. His well was an important part of his wealth, for much, if not all, of his prosperity depended upon it; and if such a well proved to be of considerable importance, by reason of the quantity or quality of the water, it bore his name for centuries. As families and tribes grew to cities and nations, the well gave place to aqueducts, and the springs and rivers of the mountains were brought to the dwellers in the deserts.

As there is nothing new under the sun, so do we find to-day the well giving place to the pond and the lake, the pump giving place to the faucet in the sink, and the vast and beautiful Metropolitan Water System of to-day supplying our needy ones with this essential element for the health and happiness of mankind.

The governments of communities find that they stand in a somewhat different position in the business of furnishing water to the citizens than they do in the details of other public utilities.

A city or town must keep its streets safe for travel and its ways in condition to allow its citizens to pass day or night without harm. Consequently it may even be considered to be bound by law to light its ways and roads. It is held that a community is not obliged by law to furnish its citizens with water, and therefore cannot claim to be acting in the discharge of a public function in thus supplying said inhabitants, but must stand in the light of a party engaged in selling the commodity. Consequently we do not tax for this as in other items of community expense.

For this reason, doubtless, many communities have hesitated about contracting liability for such a supply, and individuals have thus been inclined to see a profit in considering this an article of merchandise.

I believe that the field for the exercise of public utilities should be confined to the smallest possible limits. While it may not be possible to enumerate such things as municipal governments should consider as being within their province, and to say that no others should be added to the list, I am firmly of the opinion that the number of the activities of our communities, into which the governments should enter as participants, should be kept at the lowest limit, and that any attempt to enter new fields should be permitted only after the most careful and rigid examination.

I conscientiously believe, however, that the supplying of its citizens with an ample supply of pure water is a proper exercise of the governmental prerogative, and is a duty which should be promptly and willingly rendered.

I believe it to be the province and the duty of the government to give all of its citizens the benefits of this supply, regardless of the item of a fair return of profit on the expense of the individual supply requested.

Aside from the convenience to the individual, the health and increased happiness of the citizens far outweigh the added cost to

the community. The supply should be all that it is possible to give, and it should be placed wherever it is desired.

So strongly is this opinion gaining in the minds of men that the governments of states are taking upon themselves the duty of providing this supply, and calling into service the best talent to be obtained to see that this supply is brought to its highest state of purity. This condition is brought about partly by the fact that an adequate source of supply may not exist within the borders of a community or in a group of communities, and partly because the community or group of communities may be unable to bear the heavy expense themselves, and the larger resources of the commonwealth must be called upon to meet the larger need.

I am firmly convinced that this is an advance along the proper lines. I do not believe that the use of water should be restricted, either for domestic use or in yard or street, but that an ample supply should be provided and its use encouraged.

Water is an educator, and its abundance encourages a more general use. Cleanliness is next to godliness, we are told, and while bodily purity is conducive to good morals, fresh, clean towns or cities with green lawns and bright flowers and shrubbery are beautiful and restful to the eye; they are equally conducive to the happiness of all,— the poor and ignorant alike with the wealthy and cultivated,— and are sure to advance all to higher moral and intellectual conditions.

If communities were called upon to furnish a water supply simply for the domestic uses of their inhabitants the duty would be quite simple, or at least much simpler than it is under the present conditions, for aside from this demand of the households there must actually be a provision for the extinguishment of conflagrations and almost every community is called upon to make provision for a considerable supply for business or manufacturing purposes. So extensive is the consumption of water becoming, and so large is the quantity required, that I believe the use of water as the motive power in manufactures should be discontinued, excepting, of course, power received from flowing streams.

For fire protection the community must provide. The demand upon the water supply for the extinguishment of fires is periodic and, except in large cities, is not very heavy. The burden of expense in this regard is in the provision for distribution and providing a sufficient force to the stream to make it of value in the service.

The matter of the apportionment of the expense of constructing, maintaining, and operating a system of water supply is a perplexing one, requiring careful thought, and for which no general rule or system can be laid down, as the nature and conditions vary so widely in different locations. For water for domestic and household uses I believe the charge to the taker should be made as light as possible.

Believing as I do that it is the duty of the municipality to provide its citizens with a generous supply of pure water for domestic uses, I hold that that supply should be carried wherever it is wanted without considering the return which should come to the water plant in the revenue to be received. For irrigation of grounds a charge should be made in accordance with the amount which each householder desires to use, but he should be allowed to use what he wishes, paying therefor a fairly estimated cost of the service. For fire purposes the greater portion of the expense should go directly into the tax rate of the city or town, and should not apply at all to the water supply. As I have stated, the great expense is in the provision for distribution and for a sufficient head, and as regards the provision for distribution, all expense concerned in connecting with the main line of pipes and setting of hydrants should be a charge to the fire department and should be included in the items for which the tax provides. All expense for care and maintenance of hydrants should be chargeable to the fire department.

I am supposing that the municipality is furnishing the water in what I have said here. If a private company is furnishing the water and establishing and maintaining the entire system, the charge is to the municipal government, and the proper distribution of that expense to its several departments is the duty of the municipal government. If the municipal government is establishing and maintaining its own system of distribution, the private company furnishing the water simply, then my first method prevails.

Because of the limitation by the statutes of the amounts which cities and towns may raise by taxation, there is a constantly increasing practice among appropriating bodies to divert receipts from their proper purpose and to throw burdens of expense upon departments other than those to which they are properly chargeable.

Allow me to say in passing that this legislation is not accomplishing the purpose which was sought for, namely, the prevention of excessive and unwise appropriations by municipal governments, but

is a constant source of temptation to juggle with the appropriations, and after the limit has been reached, after every possible interpretation in appropriations to avoid the law, a resort is made to borrowing on extended time.

I believe that all limitations should be removed from the statutes regarding municipal indebtedness, and communities be permitted to appropriate whatever they wish to be taxed for, and the large burden of debt and interest would be taken from the hands of the taxpayers. The citizens would then take care of themselves, for they would immediately feel the pressure of unwise or needless extravagance and at once apply the needed remedy.

On the question whether or not the public buildings and the fire department should return a revenue to the water system there are differing opinions, and while there are some reasons why it might seem to be the only fair way, I am of the opinion that this claim to revenue should not be too strongly dwelt upon. A provision for this revenue would result in increasing the expense of government, thereby accumulating a revenue which would be used in additional expenditure. Charging the fire and municipal departments for water used would necessitate increased appropriations for these departments and would furnish an accumulation of money which would be an incentive for extra expenditure, which in the majority of cases would be unnecessary and consequently unwise.

It is impossible with our finite limitations to do exact justice to any system, and the comparatively small item of revenue from these sources, if demanded, would, it seems to me, work more injury to the citizens than the benefit to the water system would compensate for.

If we separate the domestic demand from that for business or manufacturing purposes, we are rid of the item of water stealing to a very large extent. For the latter demand the water meter should most certainly be used, and a separate supply for business uses entirely beyond the control of the party using it should be provided. For this metered service the charge should include every item of cost to which the community has been put in order to bring the supply to the doors of the business demanding it. If it is claimed that as citizens of the community they are entitled to water privileges, the demand should be met by providing for them a supply entirely independent of the business supply.

With the meter service, a thorough water inspection, and the

business demand separated, the amount of water stealing will be reduced to the minimum.

As to the question whether water should be supplied by the communities themselves or by private individuals or companies, I think what I have said up to this time substantially answers that question. If it is the duty of the community to provide water for its citizens, then the individual, either native or foreign, has no opportunity or inducement to enter the field.

Wherever there is a large aggregation of people who are not permanent residents but always temporary and constantly changing, there may be a field for private enterprise and capital. Indeed it is a subject for inquiry whether a government of a community would have the legal right to loan the government credit for an enterprise which should be almost entirely for a foreign citizenship and which might furnish a temptation and an opportunity for private aggrandizement.

For the permanent citizenship I believe it to be the duty of the community to provide the water needed for the life of that community. The fields into which municipal governments should enter are to my mind, as I have said, few, but I believe the supplying of water to be eminently the proper function of government.

So far as the cost to the citizen is concerned, it will be larger in the total under municipal management than under that of a private individual or company, but he will get more for his money and a more extended service, whether it be a water service or a lighting service. This must be the case, for under municipal control he has a voice, through his representative in the appropriating body, in the control of the business, whereas in the case of the private company he has no claim.

In order that the citizen shall have his water supplied at the lowest possible cost, the duty is laid upon the officials of the water department to make such accounting of their administration as shall show in the most complete manner the finances of the several heads of construction, extension, maintenance, operation, and control. The incidental and preliminary cost of examination for a water supply, with the consequent legislation, is an item by itself. The construction of dam, reservoir, pumping station, and standpipe should constitute another item, the several individual parts showing in detail, and the sum total showing the cost of that part of the plant. The lines of distribution throughout the community comprise another item,

and this should show in detail main lines, house connections, and hydrant connections, this latter item to be returned to the water department from the fire department.

Your service is now ready for business, and the sum total of the several items shows the cost of the plant and constitutes the water debt. To this will be added year by year a further sum for extending the system, and your annual reports should show the entire cost of the plant to the close of each year, the reduction of the debt which has matured up to the close of the year showing the net water debt.

In the operation of the plant it is hardly possible to state a line of accounting, because of the great difference in conditions in the different communities. Uniformity of accounts in the several cities and towns is wellnigh impossible, and even similarity of accounts will be found extremely difficult to arrange and maintain. Differences of charters, methods of appropriation entirely dissimilar, constitutions of governing bodies continually varying, — all these conditions combine to make the labor of one superintendent totally unlike that of any other. Differences of construction in machinery, made necessary by differing local conditions of supply and of topography, and the too frequent changes in the officials in charge of this department, still further complicate matters and augment the difficulties.

An effort to obtain uniformity of city charters is not very successful, and I think charters will always differ quite materially, for the reason that citizens of different communities differ in opinions, and the conditions and demands differ in each case.

Systems of management and of accounting will always differ, because no two men are likely to adopt the same method for the solution of difficult problems, and no two communities will be willing to adopt just the same methods for conducting their community affairs. Hence systems of accounting and methods of operation must be instructive by inference rather than by actual similarity for comparison, except in very few cases. A knowledge of the meaning of facts and figures is the power that makes tables and statistics of value. All can make figures, keep accounts, and compile statistics; not all can read their meaning.

As the blood goes pulsing from the heart to the very smallest artery in the farthest extremity of the body, refreshing, feeding, and invigorating every atom of the bodily construction, and passes back through small and larger veins to the fountain reservoir to be

sent again on its life-giving mission, so the water expense goes out in plant and the vast and varied system of distribution through public building, fire protection, and the multitude of domestic demands, only to come flowing back into the treasury in the form of revenue, to be sent out again over its course of universal comfort, convenience, and blessing.

The ceaseless round of nature and of the life of men is ever repeating itself. Seedtime and harvest never fail; men sleep and rise refreshed only to grow again weary. All the work of nature is to return again and again in a never-ending round. So communities gather from their citizens moneys to be returned to them in general benefits.

But, gentlemen, I must not weary you longer. The work in which we are engaged is full of difficulties, and many are its discouragements. In moments of enthusiasm we see the possibilities, but in the practical everyday work of life the clouds sweep over the scene, and only an occasional glimpse of what might be is all that is left to keep the soul alive; but when forms of government and systems of water works shall have passed away the soul of man that has worked its problems for the love of humanity and for the uplift of its power, that has been refreshed after the troublesome problems by visions of waste places made to blossom as the rose, shall find its rich reward and pass onward from the limitations of time into the infinite possibilities of eternity.

## DISCUSSION.

PRESIDENT MERRILL. We are indebted to Mr. Hall for his interesting and valuable paper, and it is now before the convention for any remarks which any gentleman present may wish to offer.

MR. FREEMAN C. COFFIN.* The paper which we have just heard is certainly a very suggestive one, and there are some points in it which particularly appeal to me. The speaker noted that it was desirable that the use of water should be abundant. I think that we probably all agree with him in that, but many people seem to confound an *abundant use* of water with the *unlimited waste* of it. It is certainly desirable to furnish all the water which is actually needed for use in any legitimate direction, but there is a great waste of water, and the difference between the use and the waste should be emphasized, and the fact that there is a difference not lost sight of. Without

*Civil Engineer, Boston, Mass.

going into details in relation to the waste of water, it is probably safe to say that in many cases the amount of water wasted is a very large percentage of the whole amount of water supplied in a town, even in certain cases exceeding the legitimate use of water; and while it is desirable to furnish an abundant supply, it is fully as desirable at all times to take every measure which can be taken to restrict the waste.

I speak of this at this time because there is so much said, not among those who are acquainted with this subject, but in the papers and in discussion of the subject by others, in opposition to the use of meters. Now, while it is not always desirable to use meters, still it seems to me that there is no real objection to their use, except, perhaps, under certain local conditions, where it may not pay to use them, or something of that kind. The use of meters certainly will not prevent the abundant use of water, under the ordinary rules and conditions governing them.

The gentleman spoke of the apportionment of the expense of the system for different services, and I should like to say a word on that subject. There seem to be two distinct forms of service in a water system. One is the domestic service, including the supply for manufacturing purposes, and the other is the service for extinguishing fires. As he well said, constructing a water system so as to make it suitable and efficient for fire protection increases the cost over what it would be if it were simply for domestic purposes. From the study I have been able to make of it I have arrived at the opinion that if there were to be a just apportionment of the expense, it would not be very far out of the way if the fire service were charged one half and the domestic service charged one half of the total annual expense; that is to say, the difference between constructing the system for fire protection and for domestic service combined would be about as much in excess over a purely domestic service as the combined system would be over a fire service, taking it in a rough-and-ready computation. Of course, local conditions would affect that. The tendency seems to be in municipal works to have all of the expenses finally charged to the consumer, that is, to have the revenue from consumers meet the whole annual expenditure for the service. It seems to be generally considered that that is a good business practice, but to my mind it is a question whether it is or not. It may be wise in some cases, but whether it is desirable and just to charge the consumer, who is not necessarily or not always identi-

cal with the taxpayer, a certain sum of money which the taxpayer should pay as an offset to the benefits he receives from fire protection, I do not feel sure.

There is one point I should like to speak of, something I have run across a great many times, and that is the practice of selling water for motors, for purposes of power, at a merely nominal figure. In my opinion it is wrong to sell water for such purposes at a less figure than it costs to supply it, but this is done in a great many cases.

Speaking of uniformity of accounts, I suppose what the speaker said is true, but it does seem desirable that there should be a certain uniformity in the way of statistics. This Association, it seems to me, has made a good beginning in that direction, and it would be very desirable if all the works could report in conformity with our form of statistics, thus enabling those who desire to obtain knowledge and information in regard to these matters to compare one works with another, or with some standard which they may have.

THE PRESIDENT. Perhaps Mr. Baker can give us something of interest in regard to that portion of Mr. Hall's address regarding the difficulty of obtaining uniformity in municipal accounts.

MR. M. N. BAKER.* Mr. President, I don't know that I wish to take up any very great amount of time just now with that phase of the subject, but I can say that while I appreciate most fully the difficulties involved as outlined in the paper, yet I consider them by no means insurmountable; and the matter of uniformity of accounts and statistics is so very important that I think every attempt should be made to improve upon the present chaotic condition, a condition existing not merely as regards a comparison of one city with another, but even of the accounts of a water department year by year in the same city. I think we all have reason to be very grateful for the progress that is being made and the interest that is being shown in the movement for uniform accounts and statistics, not only in the water-works departments, but in other departments of municipal governments.

I should like to say a word on the apportionment of the cost of the service between private and public consumers. There is not the need of so much to be said before an assembly of water-works men upon this subject that there is of addressing ourselves to the newspaper editors, the politicians, and the general public. There is a

* Associate Editor, *Engineering News*.

continual clamor for reduction of rates to domestic consumers, but of course such reduction cannot be carried to any great length without putting the burden upon the general public. If the burden is to be put upon the general public at all, why not charge the public for the water it is using, and thus get at the problem in a scientific way?

# THE PHYSICAL PROPERTIES OF WATER.

BY ALLEN HAZEN, CIVIL ENGINEER, NEW YORK, N. Y.

[*Read September 11, 1902.*]

The physical properties of water, about which I shall speak to you to-day, are those which relate to its appearance, and which have their origin in the foreign matters which it contains.

The rivers of New England impress one from the West as being of surprising clearness. The stones over which the water flows are clearly seen, and the brilliant transparency is a source of constant pleasure to one accustomed to more turbid waters. In the same way, and for the same reason, the public water supplies of the New England cities have been more attractive in appearance than those of many other parts of the country, and perhaps we have felt a complacency in seeing the efforts of our Western neighbors to secure waters equal in appearance to those which come to us almost without effort.

But as the world develops conditions change. Instead of pitying those who have to use turbid waters in less favored conditions, New England must now make a determined effort to keep the appearance of her public water supplies even equal to those of the Middle States.

The matter has come about in this way: The waters of the Mississippi Valley and elsewhere were discolored by clay and other extremely divided matter washed from the soil, and carried in suspension by the water. The material so carried is what is known as turbidity.

In the smallest amounts these matters make the water look as if it had milk in it; with larger amounts, the water appears muddy, and finally almost like mud. The color of such waters, as it is commonly called, depends upon the color of the particles comprising the turbidity. Gray is most common, but black and red are not uncommon. The New England waters are, in general, free from this kind of material. The river and lake and pond waters, on the other hand, contain a yellow coloring matter which has been extracted from dead leaves and other vegetable matter with which they have been in contact. This coloring matter is similar to, or possibly iden-

tical with, the coloring matter of tea, and waters carrying it have the appearance of weak tea. Some New England surface waters have more of this matter than others. In some it is hardly perceptible, but it is present in nearly all of them. The term "color" can be applied, properly, only to this kind of coloring matter, and should not be used to include the color which arises from a colored turbidity.

Turbidity may be said to be a stronger property of water than color, because it is more conspicuous, and because it covers color and renders it unimportant; this is to say, if a colored water is made turbid by adding clay to it, it becomes simply a turbid water. The color no longer shows, and, in fact, if the turbidity is removed by filtration or otherwise, it will usually be found that the color has been removed also. This is because the clay particles seem to have an affinity for the color, and probably enter into some loose chemical combination with it. Of course a slight turbidity does not serve to cover a heavy color; but, generally speaking, with both present the turbidity controls and the color ceases to be important.

As turbidity is the stronger property, it is commonly regarded as the more objectionable in a public water supply; and so it has happened that the cities having turbid waters have made the most strenuous efforts to improve them. It is true that the purification of water has been directed in part to the removal of the disease-producing properties which are so common in river waters, but the appearance has also been, always, or nearly always, an important consideration. Most people will say that to render a water hygienically wholesome is more important than to remove the turbidity; but, notwithstanding this, up to the present time I believe that the desire for clear water has been a more important factor in securing water purification than the desire for wholesome water. It is like the old case of the man who first consults his lawyer about his property; afterward, his doctor about his body, and finally, if there is time left, his clergyman about his soul. The matter which is seemingly least important receives first and most serious consideration. It has been much the same with water. Many of the cities using turbid waters have introduced the settling basins and coagulants and filters, or as many of them as necessary, and have removed the turbidity; and with the turbidity, the color, if present, has usually disappeared or has been reduced to an unimportant amount.

The cities still using such waters raw are all considering the question of purification, and within the last five years the question itself has changed. It is no longer, "Shall we filter our water?" It has become instead, "How shall we filter it? What means are to be adopted? And how shall we raise the money to pay for it?" The time is not distant when the cities that were and are supplied with turbid water will be supplied with clear and generally, also, with colorless, or nearly colorless, water.

The yellow waters of New England were far more attractive in appearance than the turbid waters of the West; but equally, the turbid Western waters are far more attractive in appearance after they have been filtered than the yellow New England waters. And so it happens that if New England is to hold her relative position, the question of the physical properties must be squarely and adequately met, and means of controlling and reducing the color must be found and applied.

It is not my purpose to describe to you to-day the methods which have been proposed and used for doing this. I wish rather to interest you in some preliminary work which is necessary to a full understanding of the question. Full and accurate knowledge of the present conditions is the best foundation on which to project plans for the improvement of those conditions; and I wish to-day to interest you in securing and keeping full daily information as to the colors and turbidities of the waters under your charge. I know that very much has already been done in this direction, particularly in Massachusetts, by the State Board of Health, the city of Boston, the Metropolitan Water Board, and others, but even in New England there is sometimes room for improvement.

The United States Geological Survey has taken the matter up. At the request of Mr. F. H. Newell, hydrographer of the Survey, I undertook last year to design apparatus for measuring the colors and turbidities of waters for the Survey. The apparatus had to be thoroughly portable, and so simple that it could not get out of adjustment. It was necessary that it should be thoroughly accurate under all conditions, and reliable even in the hands of comparatively inexperienced operators. Sets of such apparatus were designed and made for the use of the hydrographers of the Survey, and with the consent of Mr. Newell, arrangements have been made to place the apparatus on sale, by the parties who have made it. In designing the apparatus, the methods in common and approved use have been

followed, with only such slight modifications as seemed necessary or desirable.

For the color, the platinum-cobalt standard is used. Comparisons are made in aluminum tubes with glass ends, with side openings for rapid filling and emptying, as shown in Fig. 1. The standard length of tube is 200 millimeters, but shorter tubes are provided for waters with very high colors. The standard solution of platinum, because of its acidity, is difficult and dangerous to carry about; and, further, in inexperienced hands, may not be properly kept and diluted, and so the standards made from it may not have the supposed values. This is

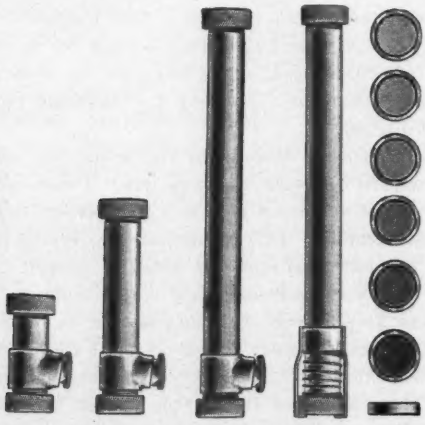

FIG. 1.—TUBES AND COLORED GLASS DISKS FOR MEASURING THE COLOR OF WATER.

met in the new apparatus by substituting glass slips of known values. Glass was found having color like the color of an average water and also like the color of the standard platinum-cobalt solution. This glass is cut into disks of various thicknesses, corresponding to the desired colors. These disks are mounted in aluminum and stamped with serial numbers for the purpose of subsequent identification. They are then compared directly with standard platinum-cobalt solution, in apparatus designed for that purpose, and the value of each disc determined. This value is then stamped upon the aluminum mounting, the figure representing the parts per million of metallic platinum which would produce an equal color when seen in a stand-

ard tube 200 millimeters long. These disks are placed singly or two at a time, as may be required, behind an empty tube, which is provided with a catch to hold them in place, and when the slip or slips so held appear equal in color to the water in another tube, held beside the one with the disks, the color of the water is the amount stamped on the disk, or the sum of the amounts, if there are two or more of them. It will be seen that this is not a new color standard, but a new method of applying an old standard. It is like the use of an aneroid in place of a mercurial barometer. The results are the same, while the method of application is so simplified as to make a very much more general use of the standard possible.

For measuring turbidity the stick method was adopted, but with a new graduation of the scale, in accordance with the recommendations of the committee of the American Public Health Association worked out in detail and defined by Mr. G. C. Whipple and the author. In principle it depends upon the distance beneath the surface of the water at which a platinum wire one millimeter in diameter can just be seen, the light being full and strong, but not direct sunlight. When the wire can be seen 100 millimeters, the turbidity is 100, and corresponds, as nearly as can be determined from available experimental results, to 100 parts per million of silica in suspension on the silica standard proposed a few years ago by Mr. Whipple. The graduation above and below has been computed from many experimental results with different waters, so that when a turbid water is diluted with a clear one, the turbidity as read will always be proportional to the amount of the turbid water in the mixture; in other words, the figures represent parts per million of suspended matters, except that equal amounts of material of different degrees of fineness produce different degrees of turbidity, and for definiteness a certain arbitrary degree of fineness is selected. This degree of fineness is such that the wire can be seen through 100 millimeters of water containing 100 parts of the material. The computation of the other points on the scale is approximate. Probably the exact graduations would differ somewhat for different kinds of turbidity-producing matter. The values were selected and arranged from the best existing data, and, if necessary, it is proposed to revise the scale when more extended data are obtained, retaining the 100-millimeter mark as the basis.

In using the stick the eye is always supposed to be 1.2 meters, or about four feet, from the wire. A straight stick somewhat longer

than this, say four and one half feet long, should be used for continued observations at one point. This is not convenient for a portable stick, and a pocket arrangement has been devised. It consists of a short aluminum bar, with a platinum wire and the beginning of the graduation. The rest of the graduation is on a tape containing bronze wires to prevent stretching, and attached so that when not in use it folds around the aluminum bar, as shown in Fig. 2. To hold it stiff in running water a catch serves to hold it to any rough stick which can be picked up upon the ground. Near-sighted people, and some others, cannot make the observation

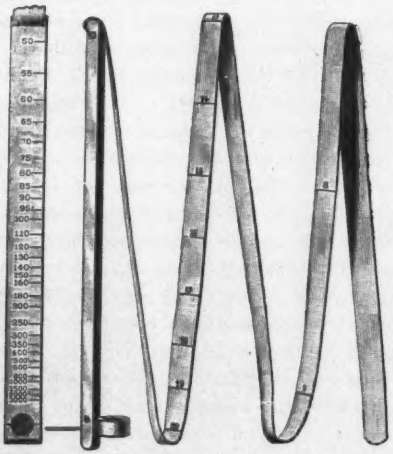

FIG. 2. — POCKET TURBIDITY STICK.

properly. It is, therefore, well for each person using the apparatus to compare his readings with those of several other people (experienced people, if possible), and to examine carefully the men that he uses for observers before placing full confidence in their results.

The whole apparatus for measuring both turbidity and color is so compact that it has been possible to put it in a case of pocket size, which will increase its convenience to many people.

The apparatus which I have described is intended to facilitate measurement of color and turbidity, and to make the results uniform and reliable. To get necessary and accurate records is an important

step, but it is only a step, and it should not be forgotten that the ultimate object is to improve the physical properties of our water supplies, which are only second in importance to their hygienic properties.

DISCUSSION.

MR. F. H. CRANDALL. I should like to ask Mr. Hazen if it is not necessary to use some precaution to prevent the sunlight affecting the glass?

MR. HAZEN. In our experience thus far, which only extends over about a year, we have seen no indication of change in the colors of the glass standards. If they should change, the glasses can be re-rated in the same way that they are rated at first.

MR. CRANDALL. You understand that they are fixed.

MR. HAZEN. So far as I know the colors are absolutely fixed. A glass will get scratched after a while in field use and will, no doubt, need to be replaced ultimately by a fresh one.

A MEMBER. I should like to ask if it is not necessary in determining turbidity that the surface of the water should be smooth, and whether it would not affect the reading if you were taking a reading on a running stream where there was a ripple on the water?

MR. HAZEN. It is always the rule to select a quiet place. In large rivers better results are secured by drawing the water in a bucket and then taking the turbidity immediately after drawing, and before settling has commenced to take place. In some cases the turbidity will be reduced 10 per cent. by waiting three or four minutes.

MR. ROBERT SPURR WESTON.* Perhaps it will be interesting to the members of the Association to give in this connection a brief summary of the experience in New Orleans during the investigation of the local water purification problem, when several thousands of turbidity determinations were made, both by the wire method, just described by Mr. Hazen, and also by the diaphanometer.

The diaphanometer used was similar to that used by Parmelee and Ellms at Cincinnati, and described elsewhere.† It consisted of a tube about one meter (40 inches) long and 30 millimeters (1.2 inches) in diameter. This tube was supported upon a box in which was placed the illuminating apparatus. At the lower end of this tube there was an object glass, the four quadrants of which were

*Sanitary Expert, Boston, Mass. † *Technology Quarterly*, vol. xii, pp. 157, 1899.

partially blackened in such a manner as to leave a transparent cross with arms one millimeter wide. This "cross-of-light" corresponds to the wire of the wire method, and the turbidity is determined by noting the vanishing point of this cross when the same is viewed against a strong light.

This cross was lighted from below by means of a Welsbach light, the rays of which first passed through a double plano-convex condenser and were reflected up through the tube from an inclined convex mirror. The condenser and convex mirror helped to destroy the image of the Welsbach mantel.

The instrument was used as follows: After the burner was lighted, water was poured in at a point near the top of the tube until the "cross-of-light" vanished from view.

The diaphanometer was standardized in a manner analogous to that employed by Messrs. Hazen and Whipple in standardizing the wire method. All results were expressed in terms of standard silica suspension, as determined from experiments made with the diaphanometer to determine the depths at which standard suspensions of silica would cause the "cross-of-light" to vanish. Thus, a water which had a turbidity of 100 caused the "cross-of-light" to vanish at the same point as a suspension containing 100 milligrams of silica to the liter.

For the purpose of comparison, turbidities were also determined by means of the wire method just described. This was done on a large number of samples, in order to determine the comparative values of the two methods.

The turbidities of many samples — those having turbidities of less than 40 parts per million — were determined by direct comparison with the silica standards in bottles or tubes. Waters having a turbidity of more than 500 parts per million were diluted with distilled water previous to the determination of the turbidity.

In general, the experiences at New Orleans went to show that determinations could be made more precisely with the diaphanometer than with the wire instrument, but that the latter was much more convenient. Furthermore, determinations could be made much more rapidly with the wire instrument.

The diaphanometer is especially useful in laboratories connected with rapid filter plants, where it is necessary to vary the amounts of applied coagulant according to the varying turbidity of the unfiltered water. As it is necessary to vary the amounts of coagulant

during the night time, the diaphanometer is very useful because it is independent of daylight, while the extremely neat and compact device just described may be used only during the hours of bright daylight, and is best used when instantaneous pictures could be taken with a camera. The wire instrument seems to be the best for general field work, and Mr. Hazen is to be thanked for having devised such a portable instrument.

At New Orleans it was found that single determinations made by the diaphanometer varied from time to time with different intensities of light, different observers and different suspensions of silica. The total variation reached 15 per cent. at times and the personal error of reading was as high as 7 per cent. among three or four observers.

The table on the following page shows the relation between the various methods for determination of turbidity, as practised at New Orleans. One column gives the equivalent values of the silica scale of the United States Geological Survey, which has just been described by one of its originators.*

It will be seen that there are some differences between the turbidity scale of the United States Geological Survey and that established at New Orleans, or, as Mr. Hazen has just expressed it, the values of the standard vanishing depth expressed in terms of silica differ. It was impracticable to exactly determine the reasons for this difference while the work was in progress. Possibly the differences may be charged to differences in the silica used as a standard of comparison.

Many of the determinations were checked by gravimetrical determinations of suspended matter. When these were compared with the turbidity determination it was soon observed that when the Mississippi River partook largely of the character of its southwestern tributaries (the Red and Arkansas Rivers), a given amount of suspended matter would produce more turbidity from an optical standpoint than the same amount of suspended matter when the river water partook largely of the character of some of its other tributaries, — notably the Upper Mississippi. This phenomenon led to the adoption of the expression "turbidity coefficient," which is a measure of the character of the particles producing the turbidity, and is a ratio between the suspended matter determined gravimetri-

* Hazen and Whipple: Circular No. 8, U. S. Geological Survey, Division of Hydrography, 1902.

## TABLE SHOWING THE RELATION BETWEEN THE VARIOUS METHODS OF TURBIDITY DETERMINATION.

| *By Direct Comparison with Silica Standards.* | *By Diaphanometer Expressed as Parts of Silica per Million.* | *Silica Scale of U. S. Geological Survey.** | *Wire Reciprocal of Vanishing Depth in Inches.* |
|---|---|---|---|
| 5 | — | — | 0.018 |
| 10 | — | 12 | 0.037 |
| 15 | — | 16 | 0.049 |
| 20 | — | 24 | 0.070 |
| 25 | — | 27 | 0.078 |
| 30 | — | 31 | 0.090 |
| 40 | 40 | 43 | 0.12 |
| 50 | 50 | 56 | 0.15 |
| 60 | 60 | 68 | 0.18 |
| | 70 | 81 | 0.21 |
| | 80 | 94 | 0.24 |
| | 90 | 108 | 0.27 |
| | 100 | 123 | 0.30 |
| | 120 | 149 | 0.35 |
| | 140 | 176 | 0.40 |
| | 160 | 198 | 0.44 |
| | 180 | 225 | 0.48 |
| | 200 | 246 | 0.52 |
| | 220 | 274 | 0.55 |
| | 240 | 296 | 0.58 |
| | 260 | 325 | 0.62 |
| | 280 | 355 | 0.66 |
| | 300 | 378 | 0.69 |
| | 320 | 403 | 0.72 |
| | 340 | 441 | 0.76 |
| | 360 | 471 | 0.79 |
| | 380 | 500 | 0.82 |
| | 400 | 542 | 0.86 |
| | 450 | 628 | 0.94 |
| | 500 | 720 | 1.02 |

**The above are average determinations on samples from all sources, Mississippi River, river and settling basin effluents.**

* Hazen and Whipple: Circular No. 8, Division of Hydrography, 1902.

cally and the turbidity expressed as the equivalent number of parts of silica per million, —

$$\text{Turbidity coefficient.} = \frac{\text{Suspended matter}}{\text{Turbidity}}.$$

Waters containing coarse, crystalline silt particles, which have a low turbidity-producing power, have a high turbidity coefficient, while the opposite is true of waters containing finely divided clay particles.

While much data has not been collected as yet, it may be said that the turbidity coefficient of American streams varies roughly between 0.5 and 1.5.

Mr. Kenneth Allen. In connection with the removal of color, Mr. Clark this morning spoke of removing from zero to 62 per cent., I think, by a single filtering through sand. It would be interesting if Mr. Hazen, or Mr. Clark if he is here, would tell us something about the effect of filtering with a coagulant by a rapid filter, and what experience has been had with rapid filtration and with a coagulant.

Mr. H. W. Clark. I think Mr. Hazen has had much more experience than I have had in the filtration of colored waters and the use of a coagulant, and I will refer that to him.

Mr. Hazen. I am sorry that Mr. Clark has not had more experience with coagulant — I have often suggested to him that he get it. [Laughter.] The color can be removed by the use of a coagulant, but it often takes a great deal of coagulant to do it. Something is known about the amount required for different waters, but it is dependent upon a whole series of conditions, and so cannot be computed by any simple formula. The amount of color is naturally the most important single condition which determines the necessary amount of coagulant, and, other things being equal, the amount of coagulant required is proportional to the amount of color; the amount of alkalinity affects it, and also the presence of other matters in the water. Generally speaking, it takes a good deal of coagulant to remove the color, and when colored waters are filtered by mechanical filters it often happens that coagulant is used only in such quantities as to remove a small percentage of the color, and the color removed is not greater than it is with sand filters. However, by the use of sufficient coagulant nearly all the color can be removed.

# ECONOMY IN THE USE OF COAL FOR THE PRODUCTION OF POWER.

BY PROF. IRA N. HOLLIS, HARVARD UNIVERSITY, CAMBRIDGE, MASS.

[*Presented November 12, 1902.*]

It is difficult to write anything new on economy in the use of fuel, especially before a society which is familiar with its uses. Many inventions have been tried of recent years with little gain of efficiency when compared with the vast amount of heat wasted in the chimney or in the exhaust of a steam engine. The rate of improvement has been a decreasing one, and, like the last knot in a 24-knot steamer, an enormous amount of human effort is required to produce a relatively small result. We seem to have reached a blind alley, out of which we can escape only by going back to try old ways long since given up or by striking out on some new path not yet indicated.

The fundamental motive at the base of all human invention is in the direction of saving labor, and thus of increasing the material comforts and leisure of the race. Broadly stated, this means that coal or water must do the work which men formerly did by hand; hence, for every ton of coal which we have been able to save by the increased efficiency of furnaces and machines, many tons have been added to the yearly expenditure by the enormously greater demand for power. We are already beginning to talk about how long the available supply of coal will last, and the late strike in the anthracite region has quickened interest in the subject, as it has given us a hint of what a coal famine would mean to a nation accustomed to depend upon it for work and heat. Yet we have hardly attacked the problem of economy in the use of coal.

A pound of good coal is capable of yielding from 14 000 to 15 000 heat units during combustion, equal, if all transmitted into work, to between 10 892 000 and 11 670 000 foot pounds. When used for heating purposes, as in reducing and blast furnaces, a very large percentage of this heat is lost at once; and when used in a boiler to drive a steam engine, a still larger percentage is lost, first in the boiler and next in the cylinders of the engine. Under the most

vorable conditions, we recover, in practice, only 1 320 000 foot pounds from each pound of coal, thus wasting more than 88 per cent. of its heat value. For every ton that is burned in a power house we throw away nearly seven and a half tons. This is only one example out of many, and as it is the one in which this society is most interested, it seems best to confine the present discussion to the use of coal in the production of power. Meantime, let us see what engineers are trying to accomplish.

The total possible saving in the steam boiler, which is given later, would be about 34 per cent. of the heat of the coal. This reckons the boiler efficiency at 66 per cent. Of the 34 per cent. referred to, we cannot hope to get back more than half, as fully 17 per cent. is required for draft, even when using an economizer. This leaves, as the maximum possible efficiency of a boiler, 83 per cent. In the case of the steam engine, the efficiency is governed by the thermodynamic law that the work is proportional to the range of heat. If we, therefore, take the upper temperature of steam at 900° absolute, and the lower at 600°, the ideal efficiency would be one third, or 33⅓ per cent., which is rarely even approached. The highest mechanical efficiency that I have ever been able to find between the steam cylinder and the power to which it is applied is in the case of the Cambridge pumping engine, where the work done in the pump was slightly over 96 per cent. of the power developed in the cylinders. This would give us 96 per cent. efficiency. Multiplying the three efficiencies together, we have the maximum attainable efficiency under ideal conditions of 26½ per cent.; that is, nearly three fourths of the heat of the coal must be thrown away, even under ideal conditions, for the working of a steam engine. We have been able, with the most economical of modern engines, to get one horse power on eleven pounds of steam, or even slightly less. This gives us about 12 per cent. efficiency. What we are working for, therefore, is the remaining 14½ per cent., and we must remember that under no conditions is it practicable with the present materials for engines and boilers to gain more. Engineers may well strive to strike out on a new path. We are struggling with the steam turbine and with other inventions to save a few pounds of coal, while we are wasting tons.

One of the axioms of modern engineering is that the conditions most favorable to economy are the regular and constant demand for power. Where an engine is to be run at its designed maximum power for twenty-four hours a day, the entire plant can be made to

realize a much higher efficiency than would be the case with a fluctuating demand for work. Where this fluctuating demand prevails, the plant must be designed for the greatest output and yet used for long periods at much lower rates. This is like employing a man to do the work of a small child, because at times there are weights to be lifted that require a man's strength. Furthermore, paradoxical as it may seem, there are many cases in which economy would be obtained only at too great a cost; a good example of this being found in steam engines for small powers. It would not pay to build a one-horse-power engine with a steam jacket and condenser and air pump. The first cost would be too great, and the skill to render the design effective would be far beyond the ordinary rate of wages. The line of improvement in the use of small powers is clearly pointed out: a central station which can be kept working at a constant rate, and some efficient method of distribution to motors of such simplicity that cheap labor can be employed to run them. This may be called the problem of the twentieth century, inasmuch as there are many demands for small power to a comparatively few for power in large quantities.

Economy in the use of coal is thus divided under three heads: —

(1) Efficiency in the recovery of heat after combustion.

(2) Efficiency of the medium by which the heat is transmitted into work.

(3) Efficiency of the machine which applies the work developed in the prime mover to a useful result.

When we consider that under these three elements of efficiency, exhaustive experiments, extending over a century, have enabled us to transmit under ordinary conditions less than 10 per cent. of the heat of the coal into useful work, we may realize the great field still open to engineers.

In a steam plant the boiler forms, naturally, the first element for study. Its efficiency is so much a question of the men who run it that we have arrived at no final type which may be expected to give the highest results. Any well-designed boiler will recover from the coal about 75 per cent. of its heat under the most favorable conditions. This falls to 40 per cent. and 50 per cent. with bad management, and it may rise to 85 per cent. with the addition of some device, usually separate from the boiler, for utilizing the waste heat. The following table, taken from a boiler trial reported in 1894 and republished in Bryan Donkin's book on "Heat Efficiency of Steam

Boilers," may serve a useful purpose in indicating the heat utilized and lost. The data were obtained from two Lancashire boilers and a Green economizer, and it is sufficiently near the average practice to serve as a type. A slight modification has enabled me to place all the data in one table.

| | *British Thermal Units.* | *Per Cent.* |
|---|---|---|
| Heat transmitted to water in boiler | 8 271 | 55.2 |
| Heat transmitted to water in economizer | 1 637 | 10.9 |
| Heat lost in products of combustion | 1 127 | 7.5 |
| Heat lost in excess air | 985 | 6.6 |
| Heat lost in moisture from coal | 23 | .2 |
| Heat lost in air leaking through brickwork of economizer | 259 | 1.7 |
| Heat lost in unburnt coal | 342 | 2.3 |
| Heat not accounted for, including radiation | 2 342 | 15.6 |
| Total | 14 986 | 100.0 |

The third item in the table represents an unavoidable loss in one form or another. Combustion is produced by the contact of oxygen with combustible material at a temperature which causes a chemical combination. The continuous combustion of coal is possible only with a regular supply of air and an equally regular withdrawal of waste products. Work is required to provide this constant current or draft, either in the form of heat supplied directly by the fuel or indirectly by means of power obtained from the steam. Under either condition a considerable amount of heat is lost which, apparently, can never be saved by any inventions affecting the steam boiler. Usually both losses occur when blowers are used, as it is never possible to discharge the products of combustion at the temperature of the air. In the case of a boiler without a feed water heater, they can never be below the temperature of the steam. The table shows that 1 127 heat units are thus lost even with an economizer. Without it the quantity would have been above 2 000. Complete combustion is not possible without an excess of air, and thus a small gain brings with it a considerable loss, as the heated air is discharged at the same temperature as the products of combustion. With blowers this excess is likely to be greater than with a natural draft. The regular supply of air is an absolute essential of economy when the supply of coal is also constant. Air entering irregularly signifies loss of efficiency. It is in this respect that the various forms of mechanical stokers have the advantage of firing by

hand. The total heat lost up the chimney from a furnace would appear by the table to be about 2 100 heat units, or 18.4 per cent. Two methods have been worked out for recapturing some of this heat, and of these the feed water heater has played by far the more important part. It has taken on various forms, but the Green economizer is that which has seemed most effective. Any arrangement by which the feed pipes are placed in the path of the products of combustion will add to the economy of the boiler, although it may also add to the repair bill.

Attempts have been made to heat the air supplied to the furnace by means of the waste products, and the Howden system has proven successful in this respect. A fan is necessary for its operation, and work is thus expended by the blowing engine in the production of draft. One point worth attention in connection with all hot-air blasts is that the amount of oxygen in one cubic foot of air is inversely proportional to the absolute temperature. Consequently, at a high temperature a greater volume of air must be supplied to consume a given weight of coal; it therefore requires greater power to drive hot air in burning coal than cold air. There is much to be said on the subject of the location of a blower, whether it be in the fire room and used to force draft by pressure in the ash pan, or in the uptake, where it creates a vacuum to induce draft. In the latter case the temperature of the products of combustion must be kept comparatively low in order to prevent an injurious change of shape of the fan.

Intimately connected with the economical combustion of coal is the prevention of smoke, the latter being only so much unburnt carbon passing off into the air, to drop on everything in the neighborhood. All of our large cities have been troubled with the smoke nuisance, upon which many inventors have set their brains to work. One needs only to go through a city like Pittsburg to realize that there is room for improvement. In the main, it may be said that devices for smoke combustion lead to economy in the use of coal, but they often increase the total expenditure of money per year. The cost of coal is only part of the total expense, and repairs to smoke consumers and patent furnaces are often large. Unless a plant is of considerable size and is run continuously, they are of doubtful value. The various forms of mechanical stokers have the advantage over firing by hand both in economy and in smoke prevention. Yet much might be accomplished by better laws in regard to licensing

firemen. It has always seemed to me that a first-rate fireman with the ordinary grate is equal to any form of patent furnace, where there is a fluctuating demand for steam. There is a vastly greater difference between a good fireman and a bad fireman than there is between a mechanical stoker and a good fireman. A good school for teaching them would be more fundamental than mechanical devices of any kind. Yet it is only fair to add that the cheaper grades of coal can be burned on patent stokers where the feed is regular. This is a decided advantage, and furthermore the extensive use of soft coal must of necessity develop a good smoke consumer. Some are now fairly satisfactory. A few years ago I ran a series of tests with a patent furnace in order to compare its results with those obtained from an ordinary grate in a boiler alongside of it. The patent furnace was something like the Murphy automatic furnace, only it had a broader plate in the bottom. The coal was fed in on the sides, and a warm blast was thrown down over it from the sides throughout the length of the furnace. This blast was caused by an ordinary Sturtevant blower. I ran a dozen or more tests with the boiler, which was of the ordinary under-fired type, and found that on the whole it was not so economical in the production of steam as the ordinary grate. In the reduction of smoke it was very effective, by diluting the products of combustion with air to such an extent that the smoke seemed to be only a small percentage of the discharge from the chimney. The neighboring boiler with the plain grate discharged into the same chimney, and I watched it very carefully when run by a first-rate fireman. The amount of smoke was undoubtedly in excess of that discharged from the patent device, even when great care was exercised in the firing, but not to the extent usually seen in the ordinary factory chimney. The amount of steam produced per pound of coal was fully up to the very best practice. It has always seemed to me, therefore, that one of the essential features of economy should be the proper education of firemen and a more rigid requirement by the state inspector. As it is at present, almost any man who knows where water goes into a boiler and where it can be blown out sets out as a full-fledged fireman. He may be very unskillful in the handling of coal.

It seems strange that up to the present time no satisfactory method of keeping the heating surfaces of boilers clean has been devised. The loss of heat chargeable to this account is very great, and the loss of money is still greater. We find it necessary to provide heat-

ing surface equal to thirty-five or forty times the grate surface to attain any kind of efficiency, yet an effective method of cleaning the surfaces would permit us to reduce them very materially, and thus to lessen the amount of material put into a boiler of given horse power. The tubes of ordinary boilers are always more or less dirty, and the water side of the tubes is almost continuously coated with some non-conducting substance. I have seen a ship gain a knot's speed simply by blowing through the tubes with steam, and that without the expenditure of a pound more coal.

The small losses shown in the table from moisture, leaks through the brickwork, and unburnt coal, are sometimes serious, but they are simply matters of care. If a fireman is allowed to turn the sprinkler on coal he is likely to cost his employer dear in the course of a year. The same may be said of too frequent cleaning of fires. The leaks through the brickwork are greater than usually reckoned, and they are avoidable only by constantly plastering up the outside. It has seemed to me that a sensible gain in economy would result from plastering the outside of a brick setting so that every crack would appear at once upon its development. In the table the loss "not accounted for" requires some study, as it appears to be quite a large percentage. There is always this unaccountable deficiency, greater or less according to the care exercised in the test which has been made.

When we turn to the steam engine we find greater losses than in the boiler. The first and most serious loss is from initial condensation. Although the steam jacket has done much to mitigate this loss, it should still be used with judgment. For many years there was a controversy on the merits of the steam jacket, proceeding mainly from the fact that the different tests were made under different conditions, and not properly comparable. Some would pronounce the jacket as of no special advantage; others would find a gain of 25 or 30 per cent. There are engines in which this gain is possible, but only when the jacket is properly used. I have lately run a test showing that there is such a thing as over-jacketing an engine and losing heat by having too much jacket steam. The case is that of a triple-expansion engine, which developed about 533 horse power. The steam was supplied to the high-pressure cylinder at 184 pounds, and it passed successively through the high-pressure cylinder, the working side of the first reheater, the intermediate cylinder, the working side of the second reheater, and the low pressure cylinder,

into the condenser. Every cylinder and reheater was thoroughly jacketed with high-pressure steam from the boiler, and the exhaust from the low-pressure cylinder passed into the condenser, with steam superheated 100°. It strikes me that this was a waste of steam, although I have never seen a similar case in connection with the steam jacket. The record of economy was about as follows: —

Without any steam on the jackets or reheaters, the steam supplied to the engine was 12.19 pounds per indicated horse power.

With full pressure on all jackets, the steam used was 12.09 pounds per indicated horse power, showing no substantial gain.

With steam on only the high-pressure and intermediate jacket and on the first reheater, the amount of steam supplied to the engine was 11.47 per indicated horse power.

There were nineteen tests run in all in connection with this engine, and the results have not been completely tabulated for publication, but the point which I wish to bring out here is perfectly plain, and that is that a test with and without jackets, as at first conducted, would have shown no special advantage of the jacket; yet a further test, with a moderate amount of steam used in the jackets, especially in the early part of the passage of the steam through the cylinders, showed a gain of six per cent. It has always struck me that the difference between the tests of steam jackets is in the circulation, and that many of them fail from a poor circulation of the steam. The success of a jacket depends entirely upon discharging all condensed water, so that the latent heat stored in the steam may become useful.

One of the chief directions for Americans to work in the use of steam is in superheating. Much more has been done in this line in Germany than in our own country. With the improvement in oils, there is no reason why an engine should not be made to work successfully under a moderate degree of superheat. This reduces materially the necessity for jacketing, and effects a saving in first cost as well as an increase of efficiency.

When all is said about the loss of heat from an engine, I am persuaded that the loss from the leakage of steam by valves is much more serious than usually appears. Very few valves are tight, and a continuous leakage from the boilers past the valves or pistons to the air or the condenser is a great drain on the coal pile. One case which came directly under my observation was in the use of a piston valve for the low-pressure cylinder of a cruiser. We were making

about eight knots an hour on forty tons of coal a day. The replacement of the packing rings in the low-pressure piston valves reduced the leak of steam to such an extent that the ship was easily able to make nine knots an hour on about thirty-five tons of coal a day. The leakage was thus fully 60 per cent. of the steam used to produce the power, and this served only to heat up the sea water discharged through the outboard delivery.

Calculations on initial condensation seem to me, therefore, very inaccurate, excepting where a careful test has been made of the tightness of all valves. Gridiron valves seem, on the whole, most satisfactory. They are far preferable to piston valves, as their tendency is to become tighter with wear, while the tendency of piston valves is to become looser.

Not much remains to be done in ordinary water works towards gain in mechanical efficiency. As stated above, Mr. Leavitt's engine in Cambridge gave about 96 per cent. efficiency. Something remains, however, in reducing the losses of ordinary power stations. A question which every engineer has to face at some time in his life, and which every owner of a factory must face, is what are the necessary items of an economical power plant. It seems to me that they may be summed up about as follows: A well-designed and well-built battery of boilers, with natural draft, using either skilled firemen and a plain grate or the average fireman with some mechanical device for a regular feed into the furnace. Some form of feed water heater or economizer should invariably be used, and some type of superheater. This provides for the essentials of the fire room. So far as the engine is concerned, either a compound or a triple-expansion engine should be used, depending upon the special conditions. Using superheated steam, the steam jacket should be used sparingly. It might not be necessary at all on the high-pressure cylinder. Feed water heaters should also be placed in the line of the steam exhausting into the condenser. The mechanical efficiency is so much a matter of inspection during the manufacture, and the proper construction of the engine, that it ought to take care of itself.

DISCUSSION.

MR. H. F. GIBBS. Mr. President, I should like to ask Professor Hollis how many horse power can be obtained from one pound of coal containing 1 300 British thermal units.

PROFESSOR HOLLIS. I should say eight and one half times as much as we get now. I have not figured it that way exactly. I know that from one pound of coal we realize 1 320 000 foot pounds. If that pound of coal was to be burned in an hour I should have to take a pencil and figure it out, but I think we should get a good deal more than we get now.

MR. GIBBS. In regard to jackets on jumping engines, I have one Blake pump, — no fly wheel, — which, if I shut off the jacket, will shorten the stroke as much as one and one-half inches, and nothing would bring it up but putting on the jacket again. I do not get as good a vacuum with the jacket shut off, and the question I should like to ask is, in the first place, if these jackets are too hot how would a reducing valve work on the jackets on the low-pressure cylinder? You know in the low-pressure jackets you get about the same temperature.

PROFESSOR HOLLIS. I think it ought to work all right, but I would not presume to tell you gentlemen anything on that subject; but on general principles I would put in a reducing valve rather than use a high-pressure steam valve.

PROF. LEONARD P. KINNICUTT.* I am afraid that I have very little that is of interest or new to say on this subject. I have listened to Professor Hollis's paper with great pleasure, for each year I am obliged to give twenty lectures to the mechanical engineers of the Worcester Polytechnic Institute, on fuels and the loss of heat that takes place in the production of steam.

The three chief causes of loss of calorific power when fuels are used under a boiler are — incomplete combustion, heating of the gases that pass up the chimney, from the temperature of the boiler room to the temperature at which the gases enter the chimney, and radiation.

As to incomplete combustion, the loss is due to part of the coal falling unburnt into the ash pit with the ashes; to part of the carbon of the coal passing unburnt up the chimney, and causing the smoke which has become so noticeable in the air of our cities during the past six months, and to part of the carbon uniting to only half the amount of oxygen which it is capable of uniting with, and consequently producing only about two thirds of the amount of heat that it would produce if it all united to the maximum amount of oxygen. The amount of loss that may be caused in these three ways by incomplete combustion often equals from 10 to 15 per cent. of the

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total calorific power of the coal. Yet this loss can, as Professor Hollis has said, be almost entirely prevented by good firing or stoking, and I also agree with him when he says that he prefers a living, thinking stoker, who understands his duties, to any mechanical device. The human stoker should, however, be trained for his work, and it is very poor economy to employ a man to fire our boilers who has no idea of the difference between poor and good stoking.

In Germany careful attention is given to the subject of firing, and, as you may know, in many of the cities of Germany there are schools for the training of stokers. These schools offer two weeks' instruction in stoking and the care of boilers. The fee is only about three dollars, and men who have been trained in this way are greatly in demand. Similar schools in this country would do much not only to increase the efficiency of a boiler plant, but would also have a decided effect on the purity of the air of our cities.

As to the heat lost by the heating of the gases that pass into the chimney, I have found that it is very often greatly in excess of that which should take place in good boiler practice. The loss is due not only to the difference in temperature of the air as it enters the grate and the temperature at which the gases pass into the chimney, but to the volume of air that is entering the grate and passing up the chimney and to the composition of this gaseous mixture. The amount of air that enters the grate can be easily controlled by a good stoker. Theoretically, eleven and one-half pounds of air are necessary for the perfect combustion of a pound of carbon, but in practice we find that we must use a little more than this, say from fourteen to sixteen pounds. Anything beyond this, however, is causing unnecessary loss of heat, and a little care in this direction may make a very decided difference in the coal bills. The composition of the gaseous mixture as it enters the chimney also makes a great difference in the heat required to raise a given volume of the gas through a given number of degrees. This loss is caused, as you all know, by the fact that it takes more heat to raise a given volume of nitrogen and oxygen through a given number of degrees than it does the same volume of carbon dioxide. A gaseous mixture of nitrogen, oxygen, and carbon dioxide containing only 7 per cent. of carbon dioxide will require 75 per cent. more heat to raise it a given number of degrees than the same volume of gaseous matter containing 14 per cent. of carbon dioxide will require. It may well be

asked, How can a stoker tell the composition of the gaseous mixture passing up the chimney, and govern his fire accordingly — he is not a chemist, and is not expected to know about gases or their analyses? This is all true, but there is a very simple device, described first, I think, by Professor Hempel, of Dresden, which can be attached to any boiler, by means of which, by merely noticing the height of a candle flame, burning in a tube containing an index card, and through which a very small portion of the gaseous mixture as it enters the chimney passes, the amount of carbon dioxide can be immediately read off. The larger the amount of carbon dioxide the gases contain, the longer will the candle flame be drawn out.

If there was only some way, as Professor Hollis has stated, of supplying pure oxygen cheaply to the fuel, instead of having to supply it in the form of air which contains only 21 per cent. of oxygen and 79 per cent. of nitrogen, a very great saving of heat would be possible. At the present time, however, there is no practical way of supplying oxygen except by using air. Some day it may be possible to do so, just as at the present time we are able to burn aluminum in oxygen not taken from the air but taken directly from a compound of magnesium and oxygen, known as magnesium oxide, and thus obtain very high temperatures. There are many compounds of oxygen and metals, like iron oxide, which occur abundantly in nature, and it is interesting, at least theoretically, to consider if some day it will not be possible to burn our fuels by means of metallic oxides, thus saving the large amount of heat that is now required to heat the 79 per cent. of nitrogen that is mixed with the oxygen in the air.

# WASTE HEAT ENGINES.

BY PROF. EDWARD F. MILLER, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON.

[*Presented November 12, 1902.*]

The best steam engines of to-day utilize in the form of work but from 20 to 25 per cent. of the heat supplied to the high-pressure cylinder. Even at these low figures the engines are giving about 80 per cent. of the efficiency of the theoretically perfect engine.

The theoretically perfect engine, or the Carnot engine, as it is called, has no losses from friction, radiation, or absorption of heat by the pistons and cylinder walls. Its efficiency is found to be independent of the working medium used, whether steam, air, carbonic-acid gas, sulphurous anhydride gas, or any other substance, but to depend simply on the range of temperature worked through and the absolute temperature of the supply.

This may be illustrated by an example: —

Let us take a steam engine using steam at 150.3 pounds gage or 165 pounds absolute pressure and exhausting at 26 inches vacuum or at 2 pounds absolute pressure, and find the efficiency of the perfect engine.

The temperature of the incoming steam is 365.9° F., or $T = 826.6°$ absolute; that of the exhaust is 126.3° F., or $T = 587°$ absolute. These values are found in steam tables.

$$\text{The efficiency} = \frac{T_{\text{supply}} - T_{\text{exhaust}}}{T_{\text{supply}}} = \frac{826.6 - 587}{826.6} = 29 \text{ per cent.}$$

The actual engine, on account of radiation, cylinder condensation, and other losses, realizes but 80 per cent. of this and has a thermal efficiency of 23 per cent. It is evident that to get an efficiency of 100 per cent., even for the perfect engine, all the heat supplied must

be transformed into work; that is, the engine must exhaust no heat. The equation for efficiency may be written, —

$$\frac{Q_{supply} - Q_{exhaust}}{Q_{supply}} = \frac{T_{supply} - T_{exhaust}}{T_{supply}}.$$

An engine which exhausts no heat would evidently have the value $T_{exhaust} = 0$, or the temperature of the lower limits of the cycle would be 460.7° below 0° F. This shows that it is impossible to attain a high efficiency because there must necessarily be a large amount of heat exhausted to the condenser. The efficiency may be increased by raising the value $T_{supply}$ in the equation for efficiency or by making the value $T_{exhaust}$ lower.

In Germany steam superheated 300° F. is in quite general use.

A calculation for the preceding case with the steam superheated 300° gives for the perfect engine, —

$$\text{Efficiency} = \frac{1\,136.6 - 587}{1\,126.6} = 48 \text{ per cent.}$$

or 48 × .80 = 38 per cent. for the actual engine.

To obtain this high degree of superheating, a special superheater with furnace is required, and the extra cost *in heat* of the superheated steam should be considered when a comparison is made with an engine using saturated steam.

It is only recently that attempts have been made to increase the efficiency of an engine by reducing the temperature of the exhaust heat. It is of this work that I wish to speak.

Prof. E. Josse, of the Königliche Technische Hochschule of Berlin, has, during the last two years, perfected an engine in which the heat of the exhaust of the low-pressure cylinder is absorbed by sulphurous anhydride ($SO_2$), which is used in the place of the cooling water in a surface condenser. The $SO_2$ is vaporized by the heat given up by the condensation of the exhaust, and its vapor is used in a separate cylinder just as steam would be used.

The $SO_2$, after leaving its cylinder, is condensed under pressure in a water-cooled surface condenser. The liquid $SO_2$ is returned to

the vaporizer by a small pump, thus making the cycle complete. The sketch, Fig. 1, will serve to show the general arrangement of such a combined engine.

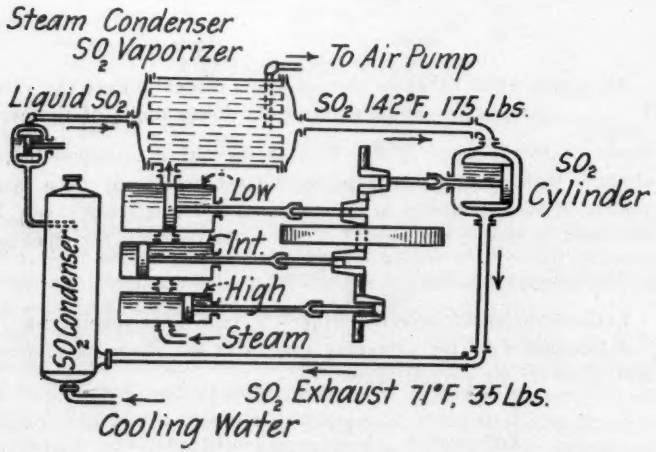



FIG. 1.

It may be interesting here to look at the pressure curves and total heat values of $SO_2$ and of steam, which are plotted on the same diagram, Fig. 2 (see opposite page). At 100° F. the pressure of $SO_2$ is 85 pounds absolute; at 160° F. the pressure of $SO_2$ is 220 pounds absolute, while that of steam is only 4.7 pounds absolute.

If in an ordinary surface condenser the temperature of the hot condensing water was 100° F. (a temperature commonly found) the substitution of $SO_2$ for the water would give a pressure of 85 pounds absolute. If the cooling water left is 160° F. it would not be possible to maintain a very great vacuum, but with $SO_2$ used in place of the water the pressure obtained would be 220 pounds absolute, an increase of 135 pounds for 60° increase in temperature.

If the cooling water leaving the $SO_2$ condenser is at 70° F., then the $SO_2$ will be liquefied at 48 pounds absolute pressure. This temperature fixes the back pressure on the $SO_2$ cylinder.

Assuming that the $SO_2$ was condensed at 70° F., what has been the gain? Take first the steam engine using saturated steam at 165

pounds absolute and with 26 inches vacuum, we found the perfect engine had 29 per cent. efficiency.

By the use of $SO_2$ the lower temperature of the cycle has been changed from 126.3° to 70°, a drop of 56°.

The efficiency figures $\frac{826.6 - 530.7}{826.6} = 36$ per cent. as against 29.

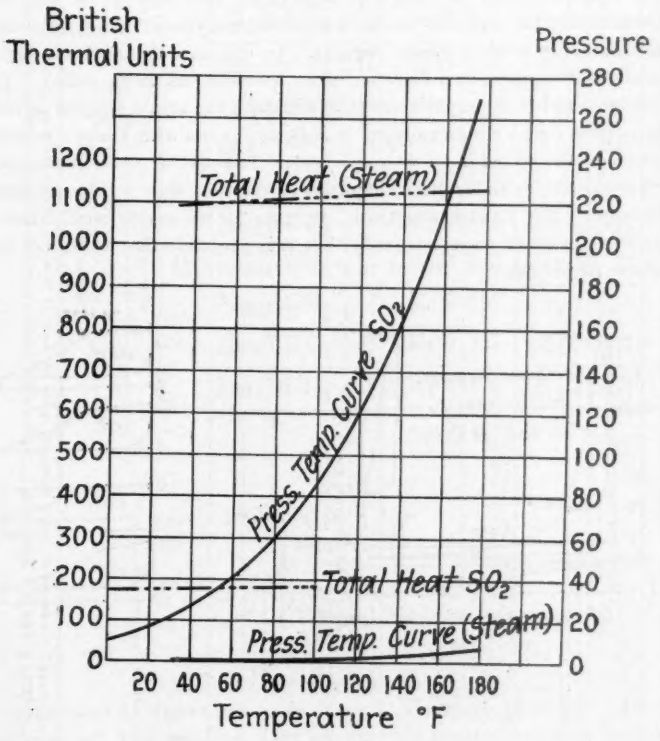



FIG. 2.

Applying the $SO_2$ cylinder to the same engine using steam of the same pressure but superheated 300° F, we have

$$\frac{1\ 126.6 - 530.7}{1\ 126.6} = 53 \text{ per cent.}$$

as against 48 per cent.

If the cooling water should leave the condenser at a temperature lower than 70° F. the back pressure on the $SO_2$ cylinder would be less, more work would be done in that cylinder, and the efficiency would be greater.

The results of a number of tests on this engine are given in the table on the opposite page. The indicator cards from the engine are reproduced on the diagram, Fig. 4, for test No. 8. It will be noticed that the vacuum on the low-pressure cylinder is not as great as commonly used on steam engines. In this case the vacuum used is about 20 inches, or a 68.5 per cent. vacuum, as it is called. It has been found by experiment that although the steam engine gives more power with a high vacuum, it is better to run with a less vacuum when combined with an $SO_2$ cylinder. The extra power obtained from the $SO_2$ cylinder more than offsets the loss due to the poorer vacuum. The precise amount of vacuum for an engine would have to be determined experimentally, but it is probable that it would be about 70 per cent.

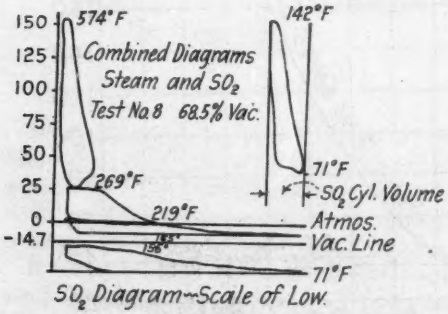



FIG. 3.

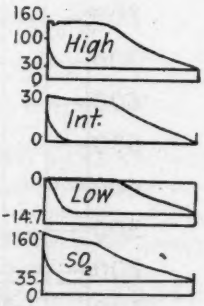



FIG. 4.

The combined diagrams, Fig. 3, show the range of temperature and of pressure worked through by each cylinder and the relative volumes of the cylinders.

The figure above and at the right in Fig. 3 is the $SO_2$ indicator card shown on Fig. 4, reduced to the same scale of volumes and scale of pressures. The figure at the bottom under the low-pressure diagram shows the same card with pressures reduced in the ratio of volume of the low-pressure cylinder to the volume of the $SO_2$ cylin-

**Tests on a "WASTE HEAT ENGINE."** **This engine consists of a triple expansion steam engine, condensing: having a sulphurous anhydride heat-saving cylinder attached. Tests by Prof. E. Josse of Kgl. Technische Hochschule, Berlin, Germany**

| Arrangement of Apparatus during the Test | | | Steam engine working triple expansion | | | | | | | | Steam engine working compound | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water from the condensation traps led into the vaporizer | | | | | | into the disch'ge pipes | Water from the condensation traps led into the vaporizer | | | | |
| | | | Superheated Steam | | | | | | | dry satu-rated | Superheated Steam | | | |
| | | | | | with high vacuum | | | | | | | | with small quantity of circulating water | at half Load |
| | Speed — r. p. m. | | 139.6 | 136.3 | 143.5 | 137.4 | 145. | 145. | 148. | 148. | 140. | 137. | 148. | 137. | 146. |
| | Volts at Dynamo | | 210. | 189.5 | 210. | 191. | 209. | 212. | 231. | 230. | 230. | 206.5 | 235.8 | 210. | 220. |
| | Amperes from Dynamo | | 602. | 625. | 584. | 414.5 | 579. | 576.4 | 610. | 610. | 609.5 | 608.7 | 531. | 470. | 272. |
| Steam Engine | Temperatures °F. | Boiler steam — admission | 534. | 568. | 590. | 583. | 579. | 579. | 590. | 574. | 373. | 630. | 619. | 630. | 626. |
| | | Degrees — superheat | 175. | 219. | 221. | 214. | 210. | 210. | 221. | 204. | | 257. | 247. | 261. | 257. |
| | Steam pressures | Inlet pressure - High-press.-cyl.- lbs. per sq. in. above atmos | 136.5 | 150.5 | 158. | 156.5 | 156.5 | 156.5 | 156.5 | 156. | 156.5 | 160.5 | 163.7 | 156.5 | 156.5 |
| | | Per cent vacuum in condenser | 80. | 80.5 | 70. | 85. | 79.5 | 69. | 68.5 | 68.5 | 68.2 | 73. | 69.1 | 70.2 | 75.2 |
| | Indicated output Horse power | High-pressure-cylinder | 59.2 | 55.2 | 68.6 | 40.9 | 59.6 | 63.6 | 76.5 | 76.2 | 59.2 | 77.5 | 86.7 | 73.9 | 50.8 |
| | | Intermediate cylinder | 43.3 | 35.7 | 43.5 | 31.3 | 42.4 | 41.1 | 42.5 | 45.0 | 47.3 | — | — | — | — |
| | | Low-pressure-cylinder | 29.6 | 34.3 | 42.4 | 29.4 | 43.3 | 39.8 | 42.9 | 42.0 | 49.8 | 44.3 | 53.8 | 43.7 | 31.6 |
| | | **Complete engine** | 132.1 | 125.2 | 154.2 | 101.6 | 145.3 | 144.5 | 161.0 | 163.2 | 156.3 | 221.8 | 140.5 | 117.6 | 82.4 |
| | Steam consumption in lbs. per hour | Condensation from the vaporizer | 1652. | 1405. | 1881. | 1465. | 1980. | 1994. | 2133. | 1775. | 2502. | 1649. | 1885. | 1612. | 1197. |
| | | Condensation from the steam jackets and receiver | — | — | — | — | — | — | — | 367. | — | — | — | — | — |
| | | Total Condensation | 1652. | 1405. | 1881. | 1465. | 1980. | 1994. | 2133. | 2142. | 2502. | 1649. | 1885. | 1612. | 1197. |
| | | **per H. P. ind.** | 12.5 | 11.2 | 12.2 | 14.4 | 13.6 | 13.8 | 13.2 | 13.1 | 16.4 | 13.5 | 13.4 | 13.7 | 14.8 |
| Waste-Heat-Engine | Temperatures °F. | $SO_2$ vapour. Admission to cylinder | 132.0 | 133.7 | 134.7 | 122.7 | 137.3 | 137.1 | 155.1 | 158.9 | 153.5 | 152.8 | 155.4 | 154.2 | 147.9 |
| | | $SO_2$ liquid. Outlet from Condenser | 60.2 | 65.8 | 67.6 | 64.4 | 66.5 | 67.6 | 68.0 | 65.6 | 70.0 | 64.6 | 66.9 | 75.2 | 65.1 |
| | | Circulating water — inlet | 49.6 | 49.9 | 49.9 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.0 | 50.0 |
| | $SO_2$ pressures (above atmospheric in lbs. per sq. in.) | Circulating water — discharge | 59.9 | 60.2 | 62.4 | 60.2 | 63.8 | 63.3 | 63.4 | 62.1 | 65.1 | 61.2 | 63.3 | 76.8 | 63.0 |
| | | in Vaporizer | 132. | 128. | 172. | 110.9 | 142.2 | 187.7 | 186.3 | 192. | 180.6 | 177.7 | 183.4 | 180.6 | 164.9 |
| | | in Condenser | 31.2 | 33.5 | 34.8 | 31.2 | 35.5 | 36.5 | 36.2 | 34.2 | 36. | 33.2 | 34.8 | 46.2 | 33.1 |
| | | Indicated | 45.3 | 42.8 | 56.8 | 31.0 | 50.1 | 57.6 | 61.3 | 54.7 | 66.0 | 48.0 | 55.6 | 40.8 | 30.6 |
| | Output — H. P. | **in per cent of steam-engine** | 34.4 | 34.2 | 37.0 | 30.5 | 34.5 | 40.0 | 37.9 | 33.3 | 42.1 | 29.4 | 29.5 | 34.6 | 37.2 |
| | Consumption of waste steam per I. H. P. per hour lbs. | Condensation from the steam jacket and receiver — Taken in to the Vaporiser | 36.5 | 32.8 | 33.2 | 47.3 | 39.5 | 34.6 | 34.5 | — | 38.9 | 34.4 | 33.9 | 39.5 | 39.1 |
| | | Condensation from the steam jacket and receiver — Led to the discharge pipes | — | — | — | — | — | — | — | 32.5 | — | — | — | — | — |
| Combined Engine | Output — H. P. | Indicated | 177.4 | 168. | 211. | 132.6 | 196.4 | 202.1 | 223.2 | 217.9 | 222.3 | 169.5 | 190.1 | 158.4 | 113. |
| | | Effective | 151.8 | 143.8 | 177.2 | 114.2 | 174.5 | 176.2 | 202.9 | 201.9 | 201. | 155.8 | 180.2 | 141.9 | 89.7 |
| | | Electrical | 140.9 | 134. | 164.5 | 106.3 | 162.5 | 163.5 | 189.1 | 188.2 | 187.2 | 141.9 | 167.5 | 132. | 83.7 |
| | Total steam consumption per hour — lbs. | | 1652. | 1405. | 1881. | 1465. | 1980. | 1994. | 2133. | 2142. | 2502. | 1649. | 1885. | 1612. | 1197. |
| | **Steam consumption per I. H. P. per hour — lbs.** | | 9.7 | 8.36 | 8.6 | 11.08 | 10.12 | 9.86 | 9.85 | 9.85 | 11.8 | 9.7 | 9.6 | 10.22 | 10.6 |
| | Quantity of circulating water in gallons | Total per hour | — | 11,600 | 13,000 | — | 12,486 | 11,330 | 12,468 | 12,584 | 13,310 | 12,144 | 12,056 | 5,236 | 3,140 |
| | | Per I. H. P. per hour for the comb. engine | — | 69.5 | 61.6 | — | 63.8 | 56.1 | 55.8 | 57.7 | 59.9 | 71.6 | 61.5 | 33.0 | 71.9 |
| | Mechanical Efficiency | Electrical Output ÷ I. H. P. | 79.5 | 80.1 | 78. | 80.4 | 82.8 | 81. | 84.5 | 86. | 84.2 | 89.5 | 85.5 | 85.5 | 74. |
| | | B. H. P.*) ÷ I. H. P. | 85.5 | 86.2 | 83.8 | 87.5 | 89.1 | 87. | 90.8 | 92.5 | 90.5 | 89.8 | 92. | 89.8 | 79.5 |
| | Number | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |

*) Dynamo efficiency assumed. 93%

der. It shows the pressure needed in a cylinder of the same size as the low to do the same work as is done in the $SO_2$ cylinder.

Sulphurous anhydride does not attack iron or composition.

The $SO_2$ cylinder does not require cylinder oil, as the $SO_2$ vapor is of a greasy nature.

$SO_2$ when combined with water makes sulphurous acid; there is, however, no danger from any acid formed, for should the vaporizer or the condenser leak, the $SO_2$ being under the greater pressure would escape into water, which is constantly changing.

### APPLICATIONS OF THE WASTE HEAT ENGINE.

Besides its use in connection with the steam engine, the $SO_2$ cylinder, vaporizer, and condenser may be used to recover some of the waste heat of the exhaust of gas engines, to recover some of the heat from the flue gases leaving a battery of boilers, etc.

The gas engine, as it is now used, has a higher thermal efficiency than the steam engine. The exhaust pipe of a gas engine is frequently of a dull cherry red color, showing that there is a large amount of heat lost. If now this heat is taken up by $SO_2$ and some power gotten from it, it would seem that the combination of gas engine and $SO_2$ waste-heat-saving engine would be far more economical than the Diesel motor on the steam engine using highly superheated steam with waste-heat cylinder attached.

From estimates as to the relative cost of a steam plant of 200 horse power, including boilers, tandem compound condensing engine, piping, etc., all complete ready to run, and of a gas-producer plant of 200 horse power with generator, gas engine, waste-heat engine outfit, including piping and $SO_2$ supply, it seems that the latter is cheaper by a few hundred dollars.

### DISCUSSION.

PRESIDENT MERRILL. Professor Miller's very interesting paper is now open for discussion.

MR. FREEMAN C. COFFIN. I should like to ask if the only additional cost of running is the cost of running the pump to return the $SO_2$ to the vaporizer, aside from the additional first cost and a slight leakage of $SO_2$.

PROFESSOR MILLER. Yes; there is one point more. By referring to the pressure temperature curve of $SO_2$ you will notice that after you get to about 100° F. the curve rises steeper than it does at the

first part. That means you can get greater pressure in your $SO_2$ cylinder if you carry less vacuum and consequently a higher temperature of the discharge from the low-pressure cylinder. It is a matter which has to be determined for each particular engine — what is the best vacuum for the output, but as far as these engines have been tested the best vacuum for economy is in the vicinity of 70 per cent.

MR. COFFIN. One more question. You speak of the efficiency of the gas engine as not varying much with the load; is that efficiency based on the indicated horse power or the actual?

PROFESSOR MILLER. On the indicated power; the engine friction, being practically constant for the various loads, becomes a smaller percentage with increased power.

MR. COFFIN. The effect is quite different for a light load, I suppose, between indicated and actual power.

MR. GEORGE F. CHACE. Do I understand that the sulphurous anhydride in any way comes in contact with the steam?

PROFESSOR MILLER. Surface condensers are used in each case, the $SO_2$ being on one side of the pipes and the steam on the other.

THE PRESIDENT. Have you anything to say on the subject, Professor Kinnicutt?

PROF. LEONARD P. KINNICUTT. I wish to ask a question. Has any substitution for $SO_2$ been tried?

PROFESSOR MILLER. I do not know that any substitution has been tried. There are other mixtures that might be tried, such as are used for refrigerating work.

PROFESSOR KINNICUTT. For what price can it be bought in this country?

PROFESSOR MILLER. I do not know what price it is sold for.

MR. R. S. WESTON. May I ask Professor Miller how much $SO_2$ it takes per horse power?

PROFESSOR MILLER. I do not know as I can give you the exact figures, but I do not think you would need much more than a thousand pounds (enough to charge the apparatus) for 100 horse power. There is always a reserve of liquid that does not vaporize, so you have quite a little spare liquid that can be called upon in case of a sudden leakage.

## PRACTICAL AND THEORETICAL PRECISION IN EVERY-DAY LIFE.

BY WILLIAM B. SHERMAN, PROVIDENCE, R. I.

[*Presented December 10, 1902.*]

So long a time has elapsed since I have had the pleasure of being present at one of these gatherings, and for this reason being a stranger to most of you, it was with a great deal of reluctance that I accepted the kind invitation of your Secretary to say a few words at one of the winter meetings. I shall not give you any finished paper on water; and, although this informal talk had to have a title, I crave your indulgence if I digress from the subject.

As the world goes, many of us are too precise and over-exact in our everyday calculation, and others there are who are not particular enough; I believe there is a middle line. We should use tact, common sense, and good judgment in applying the proper accuracy to the subject in question in order to attain in the simplest manner possible the desired result. Often we pay too much attention to the smallest and most trivial details, and in this way fail to grasp the large rounded-up whole which we wish to accomplish.

A noted poet in one of his stanzas said something like this: "For every one that dies another soul is born." Babbage, the well-known mathematician, with no poetry in his being, but keenly sensitive to precise, accurate data, wherever found, took the poet to task, correcting this general statement to read, "For every one that dies one and one third are born." Now we read poetry for the beauties of expression and thought which it contains, not for chronological data, knowing full well that the author claims free license to juggle with facts and figures in any way he sees fit that he may give rhythm to his metrical verse; and, on the other hand, we take up Babbage's logarithms not for poetry's sake, but to facilitate the solution of long, tedious calculations which we desire to have most accurate and precise.

In this case I think the correction was uncalled for. I believe there is a middle line.

Some ten or twelve years ago I was actively connected with a very interesting court case which from its peculiarity gained some notoriety at the time — The Lynn Gas & Electric Company against 23 Insurance Companies: the plaintiffs claimed that a fire caused short-circuiting, the breaking of pulleys, and the wrecking of the main engine, while the defendants, taking the opposite view, claimed that the engine raced and finally went to pieces, and the fire was the result. The late eminent engineer, Charles E. Emery, of New York, was retained by the defence as an expert witness. He made an elaborate and exhaustive calculation as to the exact time it would take for the engine to reach the limits of centrifugal force and go to pieces, massing into one unit all of the moving parts, including the jack shaft and its pulleys, and stated as a fact that the engine under its accelerating speed would be destroyed in a certain definite time. Mr. Moody, the present Secretary of our Navy, commenced his cross examination something like this: "Mr. Emery, I wish to be correct in my notes and desire that you assist me, — I am not quite sure whether you said the engine would go to pieces in 1 minute 47.2 seconds, or 1 minute 47.3 seconds." This exact theoretical testimony was placed in so ludicrous a light before the jury by the cross examining attorney that its value was entirely lost. There is surely a middle line.

Regarding expert testimony, a well-known judge, at a recent dinner given in one of our leading New England cities, stated: "In many sections of the country, and in the minds of many people, there has arisen a most violent opposition to expert testimony and a complete loss of confidence in its value."

I have in my collection a drawing made in an engineer's office which shows the layout of two batteries of boilers in brickwork, with the linear measurements carried out to four places of decimals, — to the ten-thousandth part of a foot. Now 1-10000 part of a foot is about 1-1000 of an inch, or to be more accurate and precise, 1-833 of an inch. In good practical everyday work we do not attempt to set bricks and rough boiler castings so precisely as that.

I have been greatly interested in the work of your committee appointed to prepare a standard set of specifications for cast-iron pipe, and in the discussion by the members. In other lines of mechanical work standards have been adopted and have been proven of great value to all parties in interest. Why not have a standard for pipe, which is one of your largest yearly expenditures? If all users of pipe

in this country would agree on a standard specification a great advance would be made — prices would be less and deliveries more prompt. The great obstruction to the carrying out of the plan will be that many engineers have pet ideas as to how pipe should be made, and will be very loath to give them up. The introduction of these special requirements adds greatly to the cost, for the foundryman must charge up his extra expense to somebody other than himself. This is a time of combination in many lines — assume for the moment that all of the water works in this country were brought under one management: the engineer of such an amalgamation would, it goes without saying, be selected from the foremost rank of the profession; he would have standard specifications for everything in the way of material required, including pipe, in which only his own whims would be introduced, it might be for long bells or short bells, ¼-inch or ⅜-inch lead joint, and other specialties to his own taste, but they would be *standard* for the *whole country;* and I have not the slightest doubt that water would be distributed to all of the consumers in these United States as efficiently, and as economically, as now.

In passing I would say that some thirty years ago the city of Fall River started with four classes of weights of pipe, making the outside diameter constant for all of the same nominal diameter.

Meters are another and very necessary adjunct to make complete a system of public water supply, and should be more extensively used. Water is a merchantable article when distributed through pipes, delivered to the consumer in the same manner as illuminating gas, and should be paid for in the same way, that is, by measurement. Why they are not attached to every service pipe is obvious — the first cost, cost of maintenance and large outlay for frequent testing, make their general adoption expensive. With no meter we let the consumer draw as he likes; but when we install a meter we insist on having a mechanism that will test to within a small percentage both for full pipe and needle stream. I believe that in this matter of meters there is a middle line which we should strive to attain. The first cost could be reduced, and the durability of meters greatly increased, if we would be content with a registration say within 7 or 8 per cent., always in favor of the consumer. If we can reduce the cost of the meter system by being less exacting in our requirements, then apply the saving to the purchase and placing of additional meters, we will have made a radical move in the right direction.

With a reduction of say 25 per cent., one-third more meters could be added for the same money.

When the Brooklyn bridge was first opened to the public a tariff was made for foot travelers, but it was soon found that the expense of collecting the pennies exceeded the revenue, and the bridge was made free. This was purely a business proposition quickly met, and the meter question may be met as promptly in a similar way: bring down the cost by adopting a low-priced yet durable meter that will answer our purpose for the *majority* of consumers, instead of asking for a mechanical detective of watch-like accuracy and precision in its construction, whose use is to round up the few who allow small leaks to continue or the lesser few who may endeavor to procure water at no cost whatever.

In these remarks I do not wish to be understood as decrying theoretical formulæ or close calculations — they have their proper place; but I think most of you will agree with me that sound judgment based on practical experience takes the front rank and serves as a wholesome check to theory.

The late George H. Corliss, inventor of the Corliss engine, once told me of his early experience in determining the proper thickness of a steam cylinder. For information on the subject he turned to Tredgold, then the great authority. He went on smoothly for several pages, following the calculations and reasonings, and felt elated that the information was being so easily reached. On reading the closing paragraph, however, which stated that "in order to meet all uncertainties of the assumptions in the foregoing calculation, it will be well to double the result last obtained," he said he closed the book and never referred to it again.

This Association has had an existence of some twenty years and now has a membership of 600, representing over 230 different water works throughout the country. During all this time between 200 and 250 papers on a multitude of subjects bearing more or less closely on the business in which you are engaged have been presented; and while many of them have given a detailed account of some one feature of a water-works system, only about 20 of them have been descriptive, as a whole, of the works which you represent.

Now, this is an age of specialists. There was a time when the successful civil engineer was supposed to be competent to lay out railroads, design bridges, water and gas works, sewerage systems, foundations, etc. All this is changed — to-day men devote their

entire time and energy to some particular branch of the profession, and you are specialists in your line; the majority of you being superintendents of water works engaged in the practical work of construction or maintenance, or engineers designing such works. I should like to see printed in our valuable JOURNAL a description of each water works represented in this Association.

Dr. Johnson said that knowledge is of two kinds: we know a subject ourselves or we know where we can find information about it.

I would suggest making the description in condensed form, avoiding details, simply naming the salient and peculiar features of the system.

Data such as this would place us in possession of information which could be followed up as each might desire; we should then know where to seek light and knowledge from our brothers' experience.

I suggest brevity in these descriptions, for, as you probably know from experience, a lengthy paper sometimes becomes tedious, especially if the reader is anxiously searching for some particular solacing morsel which he desires to absorb; and this puts me in mind of an anecdote of Lincoln, which many of you may be familiar with, but being pertinent, I will risk repeating it: when he was handed a voluminous report by a congressional committee on the examination of a new gun, the great man said: "When I send a man to examine a horse I expect him to give me his points; not how many hairs he has in his tail. I should want a new lease of life to read all this."

DISCUSSION.

MR. EDWARD ATKINSON. Mr. President, a gentleman once came to me to get some figures; after I had given them to him he said, "I suppose you know what a reputation you have?" I said I did n't, but should like to. "Well," he said, "there is a common saying that there are liars, damned liars, and statisticians." Said I, "My friend, figures never lie unless liars make the figures." That old saying has been lately changed, its present form is, "Liars, damned liars, and experts." [Laughter.]

The gentleman speaks of the meter system. I helped carry an ordinance through the town meeting in Brookline for a meter system for all private consumers; within two years after that I had evidence of the benefit of it to my cost and to the saving of the town. I paid my bills by my meter; one quarter the bill was 'way up, and the next three months it went higher yet. Then I dug up the pipe from

my house to my stable, and I found a leak which might never have been discovered except for the meter.

As to the standardizing of pipes, pipes are standardized in England at certain lengths, and when certain good friends of mine got a big contract for a great water service in Australia, the engineers in charge of putting it in took exception to the pipes because they were two feet longer than the English standard, and agreed to pay for the cost of cutting off the two feet rather than to disturb the standard.

There is one little incident which comes to my mind on the reference made by the speaker to Dr. Johnson. The last remark I ever heard about Dr. Johnson was this: "That the English language held a very unauthorized position until Dr. Johnson published his dictionary." [Laughter.]

## THE RELATION OF WATER-WORKS ENGINEERS TO THE FIRE SERVICE OF FACTORIES.

BY EDWARD ATKINSON, PRESIDENT BOSTON MANUFACTURERS MUTUAL FIRE INSURANCE CO., BOSTON, MASS.

[*Presented December 10, 1902.*]

*Gentlemen*, — I am glad to meet you and to say a few words upon one of the most important problems of the day — the saving of the nation from the ruthless waste by fire, perhaps the greatest waste of a wasteful people. The mere ash heap, standing for absolute destruction, averages $150,000,000 a year; the cost of distributing this loss through insurance companies comes to about $80,000,000 more; the support of fire departments beyond any reasonable need, and the excess of water supply for the sole purpose of furnishing fire protection, carries the annual fire tax to about $250,000,000. This sum is equal to at least 15 per cent. of the possible profit of the country in a prosperous year; often it amounts to a larger proportion.

The contracts of insurance against loss by fire amounted in 1901 to $25,000,000,000, of which the Factory Mutual System carried only $1,200,000,000.

In this latter system I have been interested, first, as an active director from 1863 to 1878, and since 1879 as the president of the largest company, now carrying risks for a fraction under $160,000,000. In this I am but the administrator, but with the aid of such men as John R. Freeman, Joseph P. Gray, E. V. French, and others, representing every branch of engineering, we have developed an applied science in the prevention of loss.

You are used to figures and you know what they mean. When I tell you that the annual loss outside of our lines is sixty cents per hundred dollars of the insured value, and that the expense of conducting the insurance companies is thirty-three to forty-five cents, averaging forty; while in our system the average loss for seven years has been less than four cents, and the annual expenses, including our whole scientific department, less than six cents, making a total

of ten cents against one hundred, you can make some estimate of the many millions which may be saved by the Mutual System.

It is in this effort and in the work which we are now doing to extend our methods and to conduct what we sometimes call our "Missionary Department" that we ask your coöperation. There are few organized bodies of specially trained men who can do more than you can.

I shall not speak of the technicalities of your profession, — for that I am not competent, — but I will try to bring its importance before you by presenting the whole case from my own point of view. I hope I may succeed, but I realize, as probably few men can, how many aspects the same problem may have when regarded from different standpoints.

It is your duty to prevent a waste of water, in many cases filtered water, necessarily supplied at an increased cost. It is my function to assure the most abundant supply of water, and to provide for its lavish use when the emergency comes. You are obliged to consider the increased cost of pumping, and my function is to provide for a static pressure from the reservoirs under your charge that will draw most heavily upon them. Yet in recent years and in all our insured works we have done much to save water by the installation of the automatic sprinklers, through which the least volume of water does the most effective service. In that way, you will observe, we are coöperating with you, and we may ask you to join with us in making this means of preventing loss more certain and more efficient.

In dealing with this question of the fire service of factories I must first define the word "factories" as it will be used in these remarks. It means a textile factory, paper mill, machine shop, or other establishment such as is insured by the Factory Mutual Fire Insurance Companies of New England, whose risks are mainly in the New England and Middle States. What I shall say may be applied to other factories, but must be modified by the conditions of such other works.

My remarks must be directed mainly, if not wholly, to the representatives of public water works. Very few of our risks are supplied with water by private corporations. The difficulties which we have met in dealing with these private water companies have been among the influences that have convinced me that the supply of water to a town or city is one of the functions that the town or city corporation can perform more efficiently and at less cost than the work can ever be done for by a private corporation established for the purpose of

making a profit out of the supply of water. As I have said, we have been called upon to deal with very few private corporations, and when we have witnessed unreasonable demands made upon our members and have witnessed the lack of capacity and efficiency not uncommon in this class of water works, we have laid out, whenever possible, the substitute of private reservoirs and large tanks, in order to enable our members to ignore private water companies wherever their policy has, in our judgment, been bad. I call it bad policy when exorbitant charges and unreasonable so-called safeguards by meters and the like are imposed, as they have been in some instances upon the factories or works, on the success and progress of which the towns may mainly rely.

In dealing with the relations of the representatives of public water works with factories as defined, the first factor to be considered is the necessary coöperation between the water-works engineers and the underwriters. Their objects are the same; their methods may be the same; their relations with the agents and managers of the mills ought to be the same. Wherever there is any antagonism it is a fault either on the part of the underwriters, of the manager of the factory,— not often of the water-works engineers; but there is occasional friction and lack of agreement upon the common end. This friction corresponds to that which very often originates in the attitude of new members of the Factory Mutual System toward the underwriters. They bring into the Mutual System the very common attitude of the assured toward the stock underwriter, a very foolish, injurious, and bad attitude, yet almost universal; namely, to regard the underwriter and his policy of insurance as a necessary evil, for which the premium is to be squeezed down to the very lowest possible limit, whether it represents the cost of insurance with the necessary profit to the Stock Fire Insurance Company, or whether it represents a premium so low as to be less than cost and to lead to the bankruptcy of the insurance companies if persisted in.

The next aspect of the underwriter in the mind of the average of the assured outside the Factory Mutual System is to regard the inspector as a nuisance, as a man who may be kept out as long as possible from the premises, aided as little as possible in finding defects and dangers, and often one who may be imposed upon by hanging up cheap and nasty hose in order to make an appearance of being ready to cope with a fire.

I recall a rather amusing incident. Many years since a large agri-

cultural tool works came into the Mutual System, having not long before settled a loss with other companies. Shortly after a small fire occurred in one of their buildings with little or no injury to any stock. Our former vice-president, Mr. William B. Whiting, visited the works and looked over the premises, then turning to the agent said, "Put on your men; repair the building; send us a copy of the account from your books, and we will send you a check." "What did you say?" said the agent. Mr. Whiting repeated his words. "Is that all you have to say?" said the agent. "Yes," was the reply; "why not?" Rejoinder: "We did not expect such a mode of settlement. You do not appear to try to scale down our claim." "No," said Mr. Whiting; "why should I? You are honest, are you not? You will make a fair claim and our purpose is to pay you. That is why we exist: to pay an exact and just measure of indemnity for loss by fire."

What are the causes of friction and misapprehension which occasionally arise between the water engineers and the factory mill agents, leading to urgent demands for meters and other serious obstructions to the fire service, and leading to what may be unreasonable demands or charges for keeping the water ready to supply sprinklers and fire apparatus? One of them is said to be the taking of water from the fire service for other purposes, thus avoiding the just rates which are charged for the water supplied for other purposes than the extinction of fire. There is no doubt you could prove that water has sometimes been stolen from fire pipes. I can assure you that when water has been taken in this way by any factory belonging to the Factory Mutual System and insured by them, it is unknown to the treasurer or to the owner. I think their verdict would be that any man who would steal water from a water supply under such conditions would not be fit to be trusted with the management of the factory. If you could prove to the Factory Mutual underwriters that such frauds existed and were known to the principals, we should regard such members as under the suspicion of what is called the moral hazard, unfit to be associated for mutual insurance with their fellow members.

My reason for this confidence is, that what is commonly called the moral hazard, namely, the danger that property will be set on fire or permitted to burn in order to collect the money from the underwriters, is non-existent in the Factory Mutual System. The company of which I am president has existed for over fifty years. In

that fifty years there has been but one suspicion of a fire intentionally set in order to collect the insurance money, which led to that risk being dropped at once; and even that was an unjust suspicion, removed some time later by the confession of the incendiary.

Let us now take up this subject from the point of view of the owner of a factory insured in the Factory Mutual Companies, and of the underwriters. All these risks are thoroughly protected with pipes and hydrants, with reservoirs or tanks; with very rare exception they are supplied with water from two sources, one of which is usually the public water supply, the other private. In many towns and cities these works yield the principal support of the people of the town or city and of the shops and other small establishments which have gathered around them. By so much as these works have laid down pipes and placed hydrants, is not the town or village corporation saved from a heavy expense? Suppose these great works did not put down their own pipes and hydrants, would not the town, city, or village be under the same obligation to extend the public water works and the public fire apparatus for their protection as they are for the business blocks and lesser works which do not put in their own safeguards? Are not the citizens of the town saved a large share of the taxes which would otherwise be imposed upon them for the purpose of extending the public water and fire apparatus for the protection of these mills? It would seem to me that sensible officials of cities and selectmen of towns should supply all the water needed and all the necessary facilities for putting out a fire if by so doing they save themselves a very large sum which they would otherwise be called upon to spend for putting in the pipes and hydrants necessary to the protection of these great works.

And again, if a protected mill is a little way outside the jurisdiction of the town or water company, and yet gives employment to a great many of the citizens, they might be rightly subject to a small charge when they used the water, but the idea of putting on a charge against the hydrants and sprinklers because they may at some remote time draw water from them seems to me rather an unwise economy.

Again, as to meters. What is the need of a meter in a fire service? Are there not plenty of methods for approximately estimating the quantity of water discharged upon a fire without putting in a meter that may obstruct and disable the whole apparatus and cause the destruction of the mill?

I put these ideas before you for what they are worth. I cannot

deal with the science of hydraulic engineering. I have no knowledge of the physical sciences. My function is to find the men who do possess expert knowledge, and then, whenever I can, convert their technical papers over into the plain and simple English that the average mill agent will understand. If I can then make him think that he found it all out for himself I am sure of getting the pumps, pipes, hydrants, and sprinklers to the fullest extent that we desire. We have printed a great many documents with which you are doubtless familiar: Mr. Freeman's analysis of hose streams, specifications for fire pumps, and the like. It took me about two years to get the friction of water in iron pipes reduced to such terms that I thought the average mill agent would understand it. I then printed these tables, and from time to time I have computed the relative cost of iron pipes, horizontal and vertical; of hydrants at the ground level, on the roofs and at vantage points, as compared to the cost of ladders and hose pipes; also computed the relative service. Even at the present advance in price of iron pipe the balance is very largely in favor of iron pipe as against hose and ladders; volume of water from roof hydrants as against ineffectual streams from hose painfully and dangerously carried up upon the ladders.

We have also made the plan and laid out the mill yard of an ideal mill, perfect in all its appointments at our present standard. In the Department of Insurance Engineering, on which I have made a beginning, we are publishing reports, of which I have examples with me. The report on the mill and mill yard, on the relative cost of service of pipes as against hose, and other matters, will presently be printed in No. 5, now going through the press.

I should now like to hear from you, and in the debate which may follow perhaps each may strike some snags which may be removed so as to give the water from your works a free and ample flow through our pumps, pipes, and sprinklers.

DISCUSSION.

PRESIDENT MERRILL. Mr. Atkinson's very interesting paper is now before you, gentlemen, for your consideration.

MR. ATKINSON. I shall be disappointed if you don't find some fault with me.

THE PRESIDENT. Mr. Walker represents one of the largest mill cities of New England, and I am sure we should be glad to hear from him.

MR. CHARLES K. WALKER.* Mr. President, I feel as though I was n't capable of contending against such a celebrated insurance man as the one who has just been addressing us. His paper is very good, it sounds well; I have noticed that the insurance people usually have the best papers; they are the best talkers, and they get the best of the water-works men. [Laughter.]

MR. ATKINSON. They always try to.

MR. WALKER. Yes, sir; and so far as Manchester is concerned, they always do. Now, I find that the city does n't have much of a chance to get in on these private supplies that are of so much benefit to the underwriters, and are said to be of so much benefit to the city, but the mill people do have a chance to get in and tap those city supplies. Mr. Atkinson says they are not honest, they are not good, square men.

MR. ATKINSON. Certainly I say that those who do it are not honest.

MR. WALKER. Well, they do it just the same, and if you will go around to any mill in Manchester, — I don't want to say too much because if they hear of it they will perhaps kick me downstairs the next time they see me, — if you will go around to any mill in Manchester you will find that they do steal water from these celebrated mill supplies. What do we get out of it? We have to build the reservoirs and provide the water, and all the insurance people have to do, as I understand it, is to pipe the mill. We don't collect one single cent from them for keeping the water in those pipes, but it seems to me that the city ought to have a fair compensation for keeping those pipes full of water so that these insurance men can have the benefit of the water in putting out a fire. If we bring the water to the mill and have it ready for them, I can't argue it out in any other way than that we should have a fair compensation at least for looking after them to keep them from stealing it. [Laughter.] But I won't take up your time, gentlemen, and I don't propose to get into any argument with this gentleman, because I know he is too much for me. But I say what I think always, and I do think we ought to have some compensation for looking after these things, for I know that folks do steal water from fire supplies.

MR. GEORGE H. SNELL.† The insurance underwriters ought to meet the water engineers and water boards more than they do. I

*Superintendent of Water Works, Manchester, N. H.
†Superintendent of Water Works, Attleboro, Mass.

have been on the water board in Attleboro for four years, and never yet have met an insurance man, outside of our local agents, except Mr. Atkinson. We frequently have a telephone inquiry from the underwriters' office in Boston as to what size of pipe is laid on a certain street in front of certain buildings, but that is about as near as we ever get to them. They don't seem to know our system, or the capacity of our pumps, and each time they telephone they ask what the pressure is; it does n't seem as though they made a note of it, because they repeatedly ask the same questions.

Now, with regard to sprinkler service and private hydrants: A new factory has recently been built in Attleboro which is insured by some mutual company, I don't know which, and they have put in two private fire hydrants in their yard adjacent to the factory. Those hydrants are entirely different from ours, so that we could n't connect our hose to them. Our hydrants all open to the right with a five-sided nut, theirs open to the left with a square nut, and there could be no connection made between our department and their hydrants. No one asked us what to put in, what we used, or anything about it; we simply ran our pipe to their buildings for them at their expense and by their request, and they did the rest. When they got their work finished we asked them to file a plan of their system, which they are going to do, — later. The plan they have at the present time does not really coincide with the lay-out, they having made some slight changes. After they had got the system all in they asked the chief engineer of the fire department to come and inspect it, which I had done previous to that, and, as I say, he found that there was no chance for the fire or water department to use those hydrants in any way. They have no hose themselves, but still they claim that they have complied with what the insurance people asked them to do. My idea would be that the insurance underwriters, before they put in these sprinkler systems and private hydrants, should confer with the water engineer or the commissioners and find out what would be best both for the town and for the factory. I believe that is a matter which should be looked into more carefully, and I think that the insurance underwriters should know what each town has to protect the buildings with, and should have it down so that they can refer to it at any time and know what the facilities are for the protection of the buildings.

Mr. Walter H. Richards.* I heartily endorse what the gentle-

*Engineer and Superintendent of Water Works, New London, Conn.

man has just said about conferring with the local water department. It often happens that the engineer or superintendent may know as much about the local arrangement of pipes as the insurance people do. I have noticed that although the plans of the insurance people are very nice and proper generally, yet they are always made with reference to protecting the particular property that is insured by them, without regard to the other properties that may not be thus insured. It very often happens that if a six-inch pipe, for instance, was broken it would take the pressure off the entire city, and in case of a fire somewhere else there would n't be any protection at all. When they ask us to put three or four six-inch pipes into a mill property, those pipes ought to be put where they would be beyond the possibility of an accident.

Mr. Atkinson remarked about there being two supplies, one from the water department and one a local supply. Well, it seems to me that where they are connected, as they usually are, by a check-valve, it is very possible that both supplies may come from the same source. That is my experience with check valves. I think there ought to be a consultation between the water department and the insurance people always before any plan is adopted, for the water department has interests outside of a particular mill and must protect them.

Mr. Theodore H. McKenzie.* One of the most important things that this Association can do is to appoint a committee for the purpose of determining a fair rate for the rental of water for fire protection by automatic sprinklers, standpipes, and hydrants, located on private manufacturing property.

There is no one thing that water companies have so much difficulty over as the collecting of a reasonable rental for such service. I believe the Manufacturers Mutual companies have a great deal to do with causing the difficulty.

I believe the insurance agents tell the manufacturers that they ought not to pay for fire protection, as they do not use much water, but the water companies are obliged to lay and maintain large pipes in the streets leading to the factories, and also to maintain a constant pressure in the pipes, and provide for the interest and depreciation on the large outlay. As the manufacturing business grows and the uses of water increase, the manufacturers put in private water supplies, usually pumping from a river or pond, and use the public water supply for fire protection only.

*Civil Engineer, Southington, Conn.

This Association should determine on and recommend a reasonable and proper rate for the use of water for fire protection, one rate for pumping works and another rate for gravity works, as the cost is much larger in the former case.

As to the honesty of water takers: As a rule, I believe nearly every one will take water and not pay for it if he can do so and not be discovered. A few years ago there was an instance of taking water in a surreptitious way from the system under my management at a large factory where there were hydrants, standpipes, and sprinklers; the use of water became so large that the factory people decided to pump their water from the river except for fire protection, and we were collecting a very small rental for water for fire protection. One day we were obliged to make repairs on the main pipes in the street near the factory, and soon after we began the factory operatives were standing around on the streets and informed me that the factory could not run, as they had no water to fill the boilers. I found that the engineer had been using water from the fire protection pipes for two years to run his boiler (150 H. P. or more). I have discovered other cases of the same kind where pipes for fire protection only have been tapped for use in factories.

The insurance people, especially the Manufacturers Mutuals, are making a great deal of money and paying large salaries, and the water companies are doing the insuring and getting nothing for it. The insurance companies ought to divide their profits with the water companies, or we should determine on a fair and reasonable rate for private fire protection and collect it.

THE PRESIDENT. I will say for the information of Mr. McKenzie that the whole subject of private fire supplies is now in the hands of a committee which has recently been appointed to consider it. I think the remarks of Mr. Snell are very pertinent, and that he has voiced the experience of a great many water-works superintendents. At the present time I myself am struggling with a similar proposition to the one which he mentioned. It came to me in the shape of a blue print from a factory which is just being established in our city. Inasmuch as it is pretty well known that water is not turned on in Somerville until the contemplated piping system is approved by the Water Department, we usually get information of it in that way. But the insurance people, I think, have never consulted us in the matter at all. I believe they prepared a plan and submitted it to the factory people without any consultation with the Water Department of the

city as to whether it would conflict with the distribution system or work any injury in any way.

I think Mr. Coggeshall, of New Bedford, can say something of interest on this subject.

Mr. R. C. P. Coggeshall.* I was hoping that you would leave me out, Mr. President, although I could tell quite a story if I should relate all my experience. There is no question that practically all of our corporations are open to this charge of dishonesty in connection with the use of water. There is, however, one point which has not been touched upon here, which seems to me of a good deal of importance. I think if any member of the Association would, in the case of an unmetered supply, tap in an inch pipe around the main gate into the factory yard, put a meter upon this connection, closing the main gate when the water is really not being used, he would be surprised to see the amount of water that is going through the pipe, that is, the amount which is going through in actual leaks. It amounts to considerable in the year, and that is one thing which has always appealed to me as a good argument why there should be some charge for fire protection service.

The factory people and the insurance people now submit plans to our office of all extensions, but it is only recently that that has been done. When a mill is piped for the first time, they have always done it, but the trouble has been that there have been extensions made from time to time. In a majority of cases that work is done by the city and so we know all about it, but sometimes it is done by outside contractors, and the work has been done before we knew anything about it, and we did n't have a chance to inspect it, and that has been something of which I have complained. I think there ought to be more consultation between the insurance people and the water department in that regard than there has been in the past.

It is surprising how easily a fire pipe will be tapped when a supply is wanted for some purpose or other. It is supposed that all the water actually used by a factory is to be metered, but it is n't always so. It was only this last week, when I happened to be going through the works of one of our old established corporations, that I found a connection from the feed pipe to the boiler running outside the meter. I traced it up and found it had been tapped into a fire pipe. The gate was not open. I called attention to it, and was told that that

*Superintendent New Bedford Water Works.

was only for an emergency, in case anything should happen to the other pipe.

The insurance people have always maintained that sprinkler pipes are in their best and most reliable condition when left filled with dead water. I think this true. But we continue to find these sprinkler pipes tapped for all sorts of supplies. In most cases this is done openly and as a matter of convenience, the sprinkler pipe being near at hand. In consequence there must be more or less circulation going on within sprinkler pipes. The insurance people know all about this, and I never hear of any protest. Here is a case where practice and theory fail to agree. If the insurance people would insist upon the honest preservation of the integrity of the sprinkler pipes from the controlling gate outside, onward, and see to it that such a standard was maintained, they would compel water for all other uses to be obtained from a secondary pipe. This would be a step in the right direction.

I think the insurance inspectors should go a good deal further than they do. Their interest in a way is perhaps identical with our own, and if there are any irregularities going on they are likely to discover it as quickly as we. I think they ought to notify us of every defect they find. But as matter of fact, when they find anything of the kind they keep very quiet about it.

There is another point I had in mind when I rose, and that is this: I know that Mr. Freeman has for a number of years been at work upon experiments in the use of proportional meters on all pipes, that is, a meter with a loaded check valve, by means of which an approximate indication of the amount of water which is passing through the pipe would be registered. It is certainly for the interest of the insurance people to have something of that sort, something which would not affect the value of the pipe so far as the fire pressure is concerned and yet which will at the same time act as a check upon the amount of water being used.

In relation to check valves, there was an interesting case in New Bedford, concerning which I have spoken several times before, but perhaps Mr. Atkinson has never heard of it. It was at the Acushnet Mills. They had a fire in the picker room. It was a hot evening in July, and of course all hands turned out and went down there. The fire pumps at the mill started, and in a very few minutes all the city steamers were thrown entirely out of commission, because the check valve had refused to close properly, and all the city mains in

the neighborhood were filled with salt water. All our check valves are now placed in boxes where they can be easily gotten at. They are examined by our department employees twice a year, and seen to be in proper condition, and the mill pays the expense of so doing. If the secondary supply had been fresh water in the above-cited case, we might not have noticed the failure of this check. You will readily understand that you would find it out pretty quick when salt water got into the city mains. The quality of a secondary fire supply I do not understand is ever considered. If of fresh water, is there not an opportunity, in case of failure on the part of check valves, that polluted water may enter the mains without the knowledge of the department officials, and may not this be the source of infection? For the benefit of those departments where these secondary fire supplies are of fresh water, I would add that our periodical examinations occasionally reveal a case where the check is not operating. I don't know that I have anything further to say at this time.

Mr. Walker. I should like to ask Mr. Coggeshall if he has had any experience in the shutting off of water. For instance, suppose there is a 4-inch pipe or a 6-inch pipe going into a building, so that they can get pressure, and you have a valve outside which serves to shut it off. But you find that the building is going, and you think it is about time to shut off the water; now how are you going to get to that gate? The building is going to fall, is likely to fall over on you, and there is that pipe running in there, wide open; — you can't get anybody to go and shut that gate, can you?

Mr. Coggeshall. In answer to that question I will say that my idea of a mill supply, and it is one we are now introducing in New Bedford, is that there should be simply one connection to the mill. That connection should be ample, but there should be only one. Then, upon the running main on each side of the mill supply you put a gate, in addition to the gate which controls the supply into the mill. In case the water is shut off outside for any purpose on either side of the mill, it is n't necessary to actually shut the mill supply off. The gate which controls the mill supply should always be located at a reasonable and safe distance from the mill so that it can always be got at in case of fire.

That very problem has come up this last week with the famous old Wamsutta Mill Corporation in New Bedford, which is the largest corporation we have there. They have some ten or eleven connections with the mains abreast of the building, in very much the condition

Mr. Walker suggests. Each one of those is like a service running out of the main. We propose to do away with all of those connections and enter the property from another street with one main of ample size, having the controlling gate where it can be always easily gotten at in case of fire, and run the pipe into the mill yard, and have all the connections with the sprinklers come out of the mill main pipe instead of out of the street main. The idea is that in case of a big fire there, as soon as the mill fire pumps get to working in good shape to hold the pressure, to shut the connection between the city and the mill, and let the mill take care of itself, leaving all the city hydrants for the city fire department. That is my idea of the way the thing ought to be handled, because it would be very disastrous to have a pipe of this size break where you could n't get at it.

Mr. Snell. There is one more thing which I did n't think to speak of while I was up before, with regard to charging for private fire protection and sprinkler service, in connection with this case I spoke of, where those hydrants were put in which would be of no use to the department. At the time the owner got ready to fill his tank, — he has a driven well and proposes to pump what water he uses, we simply furnishing him with drinking water and water for the sprinkler service, — after he got it set up, he telephoned to us and wanted to know if the town would n't fill it *gratis*. I told him certainly not; that he would have to take it through the 2-inch connection and pay for it. He said he was told by the insurance people that we would fill it without charge. So it seems that the insurance people try to make the manufacturers believe that we will give them a good deal more than they are really entitled to. In regard to stealing water, I believe that there are lots of people who will steal water who would not steal gold dollars to put in their own pockets. Some time ago, in a place where we relied on a meter, and where the party had been using about 4 000 feet a month, we found that the meter had been cut out. We asked him what he had done that for and he said they were testing a lot of water closets they had in the building, and they could n't afford to buy water for that. A good many people seem to want fire protection in the same way. But we made an estimate of the amount of water this party had used and made him a charge, and he settled the bill.

Mr. Coggeshall. There is one more point which I intended to touch upon, and that is the use for other than fire purposes of the hydrants in mill yards. That practice came to be so general in our

city that we were finally obliged to take vigorous measures to stop it. It got to a point where it was costing more money to keep the private hydrants, that were not supposed to be used, in proper order than it did all the public hydrants in the city of New Bedford. Those hydrants were used for about every conceivable purpose. I remember a conversation I had with one of our mill treasurers in New Bedford — and I will say that I have known him from boyhood up and he is just as honest a man as ever stood in shoes; I know him well and I know he believes exactly what he says: He said to me, "Bob, just as sure as you are alive there was never anything of that kind done in my yard. Why," he said, "I would n't allow it." The next morning after this conversation I happened to be passing by the mill, and there was an Irishman using water from the hydrant to lay the dust. I went up to the office and said to my friend, "Come to the window a minute and look out there." He did, and he wilted. [Laughter.]

Our practice now is to put seals on all the hydrants, and the result is that they are all in good order to-day, and it is very seldom that we find the seals broken. When a fire occurs we get a prompt report of same, and in case we find a hydrant seal broken, as a rule a good explanation is made regarding same. There have only been two or three cases in which we have felt called upon to apply the fine, and then it has been paid without a murmur. A rather amusing thing occurred a little time ago when a mill agent came to me and said: "I want to borrow your seal press for a little while." "What for?" I asked. "Why, we want to open a hydrant for a few minutes in order to wash the windows. I will seal the hydrant up again and will return the seal to you immediately." [Laughter.]

Mr. Henry V. Macksey.* I was engineer of the fire service inspection in Boston for a short time, and my experience with the underwriters' agents was, as a general thing, very satisfactory. It is strange, perhaps, but our greatest trouble was with the inspectors of the Factory Mutual Bureau. They seemed to come into town from all parts of the country. I was surprised at Mr. Atkinson's statement that most of his work is in New England, for some of these inspectors were Indians. They had an idea that nobody should be considered except themselves. They paid no attention whatever to our rules, and when we complained at their office the excuse given was that the inspectors did not know our rules, in spite of the fact

* Deputy Superintendent, Street Department, Boston.

that the rules were printed and hung on the valves all over the buildings inspected. They would break the seals without notifying the Water Department, and advise the occupants of the premises that it was all right, as they were the underwriters' inspectors. Those inspectors made no improper use of water, and their inspection was a good thing, still they were a nuisance to us and they caused considerable trouble. We had no such trouble with the inspectors of the Boston Board of Underwriters: we could round them up after a while, repeating our complaints so often that their superiors would not allow them to forget the department regulations.

I have one place in mind in Brighton, where there are beautiful grounds and lawns and a half a dozen hydrants. Every time a Factory Mutual inspector descended on that place during the summer the grass grew greener; but the inspector has gone, he is not in town, we can't do anything except inspect the hydrants once more and re-seal them. One reason why the water department is entitled to recompense for fire service is that it has to keep up inspection and seal and re-seal valves and hydrants.

It is very true, as Mr. Atkinson says, that not one in a thousand water takers is dishonest. I suppose that not one in a thousand of the inhabitants of Boston is dishonest, and yet it costs the city considerable for a police force, and it cannot get along without it. If we could hire horses to haul our fire engines and only pay for them when they actually work, and the owners of the horses would keep them in good condition, all ready to hitch up when wanted, and would only charge for the time taken to haul the engines to and from fires, we could have a fire department at small expense. Unfortunately, we have to pay for horses the year round, to pay firemen the year round, whether working or not. As the main object of the sprinkler and other private fire protection systems is to protect the premises where they are installed, it seems to me that that property should pay a liberal part of the charge.

We found quite a number of cases where people took water from the fire service for other than fire purposes. We never said they stole it, although in many cases we could have proven that they did deliberately steal it. In some cases the owner was aware of the fact; in most cases I suppose he was not. But you can understand the position of the man who discovers such a case. He is usually a city employee in a very low grade, he does not amount to much politically nor officially, whereas a wealthy property owner may have con-

siderable influence, and if the inspector makes a straightforward, honest report, and calls things by their right names, and states that certain people were stealing water, he might have to worry for a month or two as to whether his salary would be increased or suddenly decreased. So we tried to stop the improper use of water, saying nothing about what had been done, merely getting things right and avoiding trouble. We were not always assisted as I think we should have been by the underwriters' inspectors. I should judge from Mr. Atkinson's statement that the Factory Mutual Company is not troubled very much that way. If we could turn off a water taker as easily as Mr. Atkinson can turn off a policy holder whom he thinks is not fair we would have no trouble ; but we must supply water to honest men *and others*. There are cases where I think the underwriters' inspectors might assist us. I know of one case in Boston where we had to argue with the owner for over a year to stop his engineer from using water improperly. In the meantime two sets of insurance inspectors had been over the building. They knew just as well as we knew that the water was being improperly used, but they never objected, although it was strictly contrary to their own rules that water should be taken from the system for anything but fire purposes. They could hardly fail to see it, because the main supply pipe for fire purposes was constantly dripping.

I read through the underwriters' rules very carefully when I went on this class of work and thought, if the underwriters will make people live up to them what a great help it will be. I called the underwriters' attention at one time to the fact that a party was filling his fire supply tank through a by-pass on a fire supply pipe. That was against the rules I was working under. I reported to my superior several times, but he was apparently unable to stop it. I went to the underwriters' office and asked if that wasn't against their rules. They said it certainly was, and they would be very much pleased if I would stop it. They did not stop it, although their rules distinctly stated that water must not pass through the fire pipes to the tank, but only from it.

The underwriters do not always help us as much as they should, and I think these private systems put the cities and towns to considerable expense, for which they should be reimbursed. In Boston the Water Department is supposed to live by its own revenue, and it has been able to do so until recently. Now it is not able to supply the general fire protection that is necessary, because of lack of means.

It is only fair that where it has to lay mains, inspect services, and inspect the buildings, some revenue should come to it to help bear the burden.

THE PRESIDENT. Mr. Chase, of Derry, N. H., has been laboring with this question for some months past, and we would be glad to hear from him.

MR. JOHN C. CHASE. I have listened with a great deal of pleasure to Mr. Atkinson's interesting paper, and would not be disposed to offer anything in the way of comment except for the fact that he seemed to think that he was going to run up against a regular Donnybrook Fair here, and that he would not feel satisfied or think he had got his money's worth if he did not go away with a broken head. [Laughter.] So it seems to be up to us to find all the fault with him that we can.

MR. ATKINSON. That is what I expected, and is just what I want.

MR. CHASE. I think it is pretty well known in this assemblage that I have been a non-believer in charging the individual consumer for water that is used for fire purposes, holding that so long as the water department undertakes to furnish a supply for fire protection it should make no difference to the consumer whether the water was taken from the public hydrants or used through a properly supervised private system. But that is neither here nor there. The only comment I have to make is this. I understood him to say that he thought the mantle of the water department should be extended over Factory Mutual clients whose establishments were outside the city limits. I know that charity should cover a great many things, but it strikes me that this is going a little bit too far. When a corporation, as is frequently the case, locates outside the city limits for the express purpose of evading the taxation, required in part for the maintenance of efficient water and fire departments, I think that it should be shown no favors whatever. This is all that I have to offer in the discussion.

MR. ATKINSON. I have made a few notes as we went along, gentlemen, and I should like to say a few words now in reply. First, our friend from Manchester says there is no question that every one of the corporations is guilty. Well, whom do I deal with in Manchester? For instance, I deal with the treasurer of the Amoskeag Company, and the other treasurers; I deal indirectly with the agents in charge of the mills. I am sure that not one of

those men would permit water to be taken surreptitiously. If they knew of such a case they would stop it instantly. I know them all. Now, I would like a case, a specific case, mentioned here. No names need be given, but let me have a single instance and you may be sure of a complete inquiry.

Again, it is said that actual leaks might well be paid for. That is a suitable matter for negotiation between the corporations and the water board. It is said that extensions should be submitted. They certainly should, that is surely a matter between the corporation and the water board. What have the underwriters to do with it? We may advise, but the corporation executes.

It is intimated that the underwriters should pay something. Who are the underwriters, speaking now only of the Mutual underwriters? We are only the agents of the members, in custody of their money. We have no money of our own; no capital. We receive the annual premiums, so called, from which we deduct the loses and expenses, and at the end of the year we return to the owners all there is left. The Mutual underwriters are not organized to make money; they are organized to save money. So much for that point.

A case is mentioned where a corporation tapped into a fire pipe for an emergency. Is there any objection to that, with honest men? Why might they not properly protect their fire apparatus and their engine and their works against an emergency? Is n't that an easy thing to be arranged with such men as those I have mentioned, and with men of the character and standing who are in charge of the mills in Manchester, New Bedford, and elsewhere?

The Mutual underwriters positively object to a tap being put upon a sprinkler service for any purpose whatever, because we do not want the water in the sprinkler service to move. We do not want the pipes flushed; we want the water to stay there as still as it can, even for twenty years. And why? Because when the water first goes in, what oxygen there is in the water causes corrosion up to a certain limit, and there it stops. If the water moves through the sprinkler pipes it will keep up slow corrosion, and by and by we will have our sprinkler heads filled up with oxide of iron so that they won't work. No intelligent mill man will permit a sprinkler pipe to be tapped for any purpose, except possibly for one-inch small hose. When any other tap is found our inspectors report to us, and it is cut off. Some of our inspectors may overlook it, but we

employ different inspectors with different kinds of spectacles. One man has an eye for one kind of hazard, and he sees that; the next man might overlook that fault, but he sees another. When our members object that our inspectors keep finding new faults, I reply, "What are they there for? If they didn't find fault, where would you be? That is what we employ them for. If any of them find any unreasonable fault, every report that we make to you has printed at the head of it 'If you think the suggestion unreasonable or injudicious, you will immediately refer it to the executive officers of the insurance company, and either you will be persuaded that the inspector is right, or we will instruct the inspector not to do so again.'"

The case of the Acushnet Mill is spoken of, where the check valve let in salt water. We have aided as far as possible the New Bedford commissioner to remedy that defect.

MR. COGGESHALL. That is true. I only brought that up as an instance of the unreliability of check valves.

MR. ATKINSON. He says that one connection at each mill is all there should be, but that should be ample. We shall be very glad to have that plan carried out in New Bedford and everywhere else. We desire to have the check valve removed from the point where in case of fire it would be difficult to handle it. That is for our interest as well as for yours, and our men are coöperating with you to that end.

Now, bear in mind, gentlemen, that we have had no big fire anywhere for seven years, so that a big draft of water for fire protection for the Factory Mutual risks is very infrequent; I hope it will continue so. But I know that at some time somewhere every forecast that the human mind can make will fail, and we will have another big loss. The last big loss that we had was in October, 1895, and that was in a most unexpected place and for a most unexpected cause.

Mr. Snell, of Attleboro, speaks about a man asking to have his tank filled free, and so on. If any insurance man told that man that his tank would be filled without charge, he had no authority to do so and he was a greenhorn. We never knew anything about it. If it had come to my knowledge that such instruction or information had been given, I should have told that inspector what to do. We have but one risk in Attleboro in the mutual companies, and that is this new risk in which the hydrants cannot be connected with

the city service. That brings up the very difficult question of the lack of uniformity in pitch of hydrant threads, etc. We do not in the mutual system depend very much upon the public fire department, especially in the towns of lesser importance. In the cities, such as Lowell, Lawrence, Saco, New Bedford, etc., there is usually a good understanding between every mill agent and the chief of the fire department, that the fire department may be summoned and will come; and while the chief engineer has, of course, the legal right to take the entire charge of putting out the fire, yet, as a rule, he leaves the mill fire department to do the work as far as possible, and not till an emergency arises is the public fire department called in. Our hydrants may occasionally vary from those of the city department, but we depend really more upon the private service than we do upon the public fire department; it is sometimes a necessity that there shall be a variation.

It is said that we should send the plans of our hydrant service to the water-works departments. Well, that is an excellent practice which has been established by us in respect to all the mills that we insure, but we do not execute the plans that we lay out. If extensions are not submitted, all that the engineer in charge of the water works will have to do will be to send to us, and we will see that it is done. We intend to coöperate perfectly.

"The insurance men ought to pay," says our friend from Manchester. I have said why we cannot pay, and that is because we have no money to pay with. We are only the custodians of the owners' money for each year. It is for them to negotiate what payments if any are due.

I wish that we could get around that difference in the pitch of threads and in couplings. We have in the larger cities to a very great extent, but in the smaller towns, and especially in those where we have but a single risk that matter does not always come to our notice. Whether those hydrants in Attleboro might well have been made uniform with those of the public department or not is an open question; probably it did not occur to the man who laid out the work before we took the risk. However, as I say, we have but one risk in Attleboro.

There is not a single mutual risk in New London; therefore the criticism of the gentleman from New London does not apply to the Factory Mutuals, to which I limit this discussion.

In reference to what Mr. McKenzie, of Southington, Conn., says, I will remark that I think we have no risk there. I may say that the

mutuals are divided into what are called the senior companies, which are the most conservative companies, in which are insured about eight or nine hundred millions, and the junior companies, which are extending their service over a wider area, taking in some mills of a different class. I do not recall the name of Southington on any of the senior route books, therefore I think Mr. McKenzie's criticisms must apply to the inspectors of other companies and not to ours. *

Mr. Macksey, of Boston, makes certain charges against the Factory Mutuals. My company has but four risks in Boston. We did have five, but there was a little friction between myself and the owners on some point in the protection, and I dropped the risk. We have but four in the whole city of Boston, and there are only two others in the junior mutuals. There are no Indian inspectors in their service. Reference was made to a certain risk in Brighton. I can identify that risk, and I know that no factory mutual company has any policy upon it. Hence, Mr. Macksey's criticism of factory mutual inspectors must be a product of his imagination, especially the Indian. Mr. Macksey made an excellent remark to the effect that there may be one dishonest man in a hundred who will steal water where there is one dishonest man in a thousand who will steal goods, and that we keep the police to take care of the rogues. The executive officers of the senior mutual companies do not insure rogues, and would quickly cancel policies if on proper information and proof they learned that a rogue had deceived them. It is the same with the bankruptcy laws. It is not worth 25 cents on $100 to guarantee the prompt payment of every obligation entered into to-day, which aggregate the amount of $130 000 000 of trade in the United States. More than 99¾ per cent. of those obligations entered into to-day in goods alone are paid in order that we may have our breakfast, dinner, and supper on our tables. Less than a quarter of one per cent. of merchants, manufactures, and traders fail; the bankruptcy laws exist to care for that small proportion. I am inclined to think that debts would be as promptly collected as they now are even if there were no bankruptcy laws in existence anywhere. Character stands for more than capital, and if you are not able to collect your debts at law, you perhaps would look out a little more sharply as to whom you trusted. It is not because most men are honest in the moral sense. Policy and honesty are synonymous terms. Unless his obligations are met, a man must go out of business.

* On correcting I find no mutual risk there.

The suggestion is made that the mutual risks should extend their benefits to other property. Well, they do spend the money for their own protection, but they do at the same time save other property to an immense amount. The recent conflagration in Paterson, N. J., came down under a gale of wind through the city upon a group of silk mills, a part of which were mutual risks fitted up under our instructions to defend themselves. There were six powerful steam pumps which could be put in operation, two of which were held in reserve. Lines of hose were run out to meet the fire in every direction, and so exact was their work that on the plan which we have prepared you can see the line where our risks and our apparatus stopped that conflagration, which, had it gone through the silk mill district, would have caused a loss of $10 000 000 more, and would have ruined the city of Paterson in its silk industry. For seven hours these pumps were in operation without a break, and the strong underwriter hose prescribed by us did not burst in a single section. That is only one of many instances in which the apparatus in our factories has stopped fires which were beyond the control of the departments of the towns or cities.

Before the great Thanksgiving fire took place in Boston, although we had no interest in the property, I had tried to stop the construction of the building on Kingston Street in which it started, by representing to the mayor its danger; I had written him a seven-page letter stating what would happen if a fire started in that building: how it would cross the street; how the iron roof on the building opposite would come crashing down; how it would block the street and impede the firemen; probably killing some one, as it did; then how the fire would go on extending. Seven years later, when the fire occurred and the things actually happened that I said would happen, the fire marshal sent down to me and wanted to see a copy of that letter. I gave him one, and by changing the tense he made that letter the description of what had happened. For trying to do that service I was threatened by the architect with a lawsuit for $20 000 damages for having injured his reputation. I invited him to sue and be, etc., but he never sued me. [Laughter.]

The gentleman from Taunton says that the underwriters ought to know the pressure, etc., but that they are frequently sending to him to find out what the pressure is. I venture to say that you cannot go down to my office and look at a plan or record of a single mill where you will not find that we have the pressure, sizes of pipe, etc.,

all on record. I don't believe you can find one; so you don't very often have that question asked by us, unless we think there has been some change in the pressure. I believe I have had occasion to write to Taunton, because they depend upon the Holly system; is n't that so?

MR. CHACE. Yes, sir.

MR. ATKINSON. Well, we never had entire confidence in the Holly system, we therefore watch it. Then Mr. Chase, of Derry, N. H., speaks in regard to mills that are built outside the lines. We have n't any risk in Derry, but there are mills built outside the lines in some places for the purposes which Mr. Chase speaks of. There are other mills built outside the lines without the slightest regard to the rate of taxation, but for convenience of access and for other purposes.

Now, gentlemen, I think I have shown you how the mutual underwriters try to coöperate, and how, if any one of you wants and will give the opportunity for further coöperation, you can get it. And this leads me to the last point I will make. I advise you on some occasion to ask Mr. Osborne Howes, the head of the Boston Underwriters' Union, to come here and try to bring about coöperation with the other companies. The Underwriters' Union have adopted here in Boston an excellent system of inspections. One of our best inspectors entered their service years ago. They are doing everything they can do. They have rendered Boston the safest large city in the country. There is less conflagration hazard here now than there ever was before. I am sure they will do their utmost to coöperate with you.

I make no denial that there are certain, reasonable charges that might be made. There are other charges which we consider extremely unreasonable and injudicious, and which will imperil the protection of our risks; and those we take exception to. The class of men, some of whom I have designated in Manchester and that might be named in New Bedford, are to be trusted. Is there any head of a corporation in either city who would take water surreptitiously?

MR. COGGESHALL. No, sir; that is not the point I made. It is the other fellows who do it.

MR. ATKINSON. Then why don't you go right to headquarters?

MR. COGGESHALL. We do.

MR. ATKINSON. Then you stop it, don't you?

MR. COGGESHALL. Not always.

MR. ATKINSON. I have been a mill man and have run mills for many years before I became an underwriter. If I had in my employ a man whom I knew would steal water from the city fire service I should say, "That man will steal my property, and he quits my employment next week."

MR. CHACE. I want to say one word in explanation. We in Taunton have the utmost respect for the speaker and for his company, but I want to say with regard to the Holly system that for twenty-seven years we have practically not had a fire get away from the place where it started.

MR. ATKINSON. I know that.

MR. CHACE. And I may also say that I remember a fire occurring there not so very long ago, where the boiler room got so hot that the engineer and fireman could not get into it, and we put the fire out. In that case their fire pump was of no use at all.

MR. ATKINSON. That is so, and we now require all boiler rooms to be sprinklered. It has been one of the hardest jobs we ever had to do to induce the owners to do that. We do not now take a risk unless the sprinklers are complete.

MR. F. H. CRANDALL (by letter). This matter was under consideration at the recent annual convention of the Central States Water Works Association, held at Indianapolis. The subject was clearly and forcibly introduced by Mr. C. E. Inman, of the Warren Water, Electric Light and Power Company, of Warren, Ohio.

Attention was called to the possible impairment of the service by the wasting of water from such connections, both through sprinkler heads in time of fire and through leaks habitually and constantly permitted.

During the discussion a case was mentioned where one third the saving in insurance was charged for protection; one where eight dollars per quarter for each ten thousand square feet of floor space was charged, and they were considering the advisability of using meters.

Fifteen cents per annum per sprinkler head was suggested as a very reasonable rate, and metering received favorable mention.

Mr. Inman says, "Both the insurance companies and the plants using such services wish to get them for nothing, though it saves both thousands of dollars per annum. Neither likes a meter. They not only want the service free, but they want a free hand in the introduction of the system.

"This must be universally adjusted sooner or later, as their demands are unreasonable. They should pay what the service is worth. We have water-works conventions every year. It would seem that such questions as this would be settled on some uniform basis by the managers of water works, but it is passed by and the insurance companies get the service free in many cases, because the cities give it to them at the expense of the taxpayer, and if you and I do not do likewise, the trick is to make us trouble if possible, so as to get an important service for nothing, on which the insurance companies draw rich premiums and the owner of the local plant has his insurance cut to about one-third after the service is established. And both think the parties furnishing this service should receive nothing, as the plant is of local interest, and must be nursed with the bottle.

"Water companies who sell water for domestic use, being bound by their franchise, cannot afford to run chances of being defrauded without compensation, and it is my object in bringing this paper to your attention that a more uniform rate may be brought about by this Association. I know of no better place to start a reform in this matter than right here."

At the close of an interesting discussion, during which numerous experiences of illegitimate use, unreasonably large services, and various methods of assessments were recounted, a resolution was unanimously passed expressing the sentiment of the convention in favor of an equitable charge for the protection afforded by private fire services.

## STANDARD SPECIFICATIONS FOR CAST-IRON PIPE AND SPECIAL CASTINGS.

[*Note by the Editor.*]

Since the publication of the last issue of the JOURNAL, the tables of special castings to accompany the Standard Specifications have been completed, and the specifications with the tables have been issued in pamphlet form. Copies of this pamphlet have been sent to all members of the Association; also to the superintendents or engineers of the large water works throughout the country not represented in the Association, and to all the pipe founders, with the following letter: —

715 TREMONT TEMPLE, BOSTON, MASS.,
FEBRUARY 16, 1903.

*Dear Sir*, — For the purpose of securing more uniformity in the forms and dimensions as well as methods of manufacture of cast-iron water pipes and special castings, after careful consideration of the subject by a committee consisting of Freeman C. Coffin, Dexter Brackett, and F. F. Forbes, and after conferring with a number of manufacturers of cast-iron pipe in the United States, the New England Water Works Association has adopted a standard form of specifications and standard patterns for pipes and special castings.

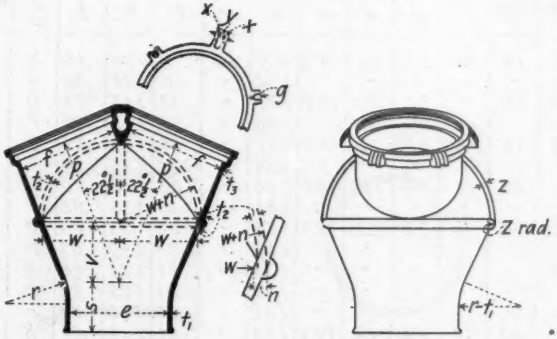
A copy of these specifications is sent you herewith, with the request that, so far as possible, you will make use of the same in ordering pipes for work under your charge.

The members of the Association and others desiring additional copies of the specifications may obtain them of the Secretary at ten cents each.

CHARLES K. WALKER, *President.*
WILLARD KENT, *Secretary.*

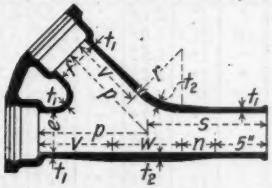
The tables of special castings which were lacking at the time of the publication of the December, 1902, issue of the JOURNAL are printed in the following pages, in order that the record may be complete.

# Y Branches




## Type 1 12" to 48"

g = 2.50" for 12" to 24" bells. g = 3.00" for 30" to 48" bells.
x = 1.25" " " " " " x = 1.50" " " " " "
y = 1.62" " " " " " y = 2.00" " " " " "
Z = 1.00" for 12" to 14" bells, 1.25" for 16" to 30" bells, 1.50" for 36" to 48" bells.




## Type 2 4" to 16"

| Dimensions in Inches | | | | | | | | | | | Type | Class | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nom. diam. e | f | s | p | v | w | n | r | $t_1$ | $t_2$ | $t_3$ | | | |
| 4 | 4 | 11.5 | 10.5 | 7.18 | 6.64 | 3.18 | 6 | .48 | .60 | | 2 | K | 105 |
| 6 | 6 | 13.0 | 13.0 | 9.27 | 7.46 | 4.27 | " | .54 | .65 | | " | I | 175 |
| 8 | 8 | 14.0 | 16.0 | 11.85 | 8.30 | 4.85 | " | .63 | .75 | | " | I | 280 |
| 10 | 10 | 15.5 | 18.5 | 13.94 | 9.12 | 5.94 | " | .70 | .85 | | " | H | 415 |
| 12 | 12 | " | 21.5 | 16.54 | 9.92 | 5.54 | " | .77 | .95 | | " | " | 610 |
| " | " | 16.0 | " | 8.00 | 9.79 | 1.19 | 30 | " | 1.10 | .77 | 1 | " | 715 |
| 14 | 14 | " | 24.0 | 18.62 | 10.76 | 5.62 | 6 | .83 | 1.00 | | 2 | " | 785 |
| " | " | " | " | 9.00 | 11.30 | 1.29 | 30 | " | 1.19 | .83 | 1 | " | 915 |
| 16 | 16 | 17.5 | 27.5 | 21.70 | 11.60 | 6.70 | 6 | .90 | 1.10 | | 2 | " | 1110 |
| " | " | 17.0 | " | 10.50 | 13.00 | 1.41 | 30 | " | 1.30 | .90 | 1 | " | 1290 |

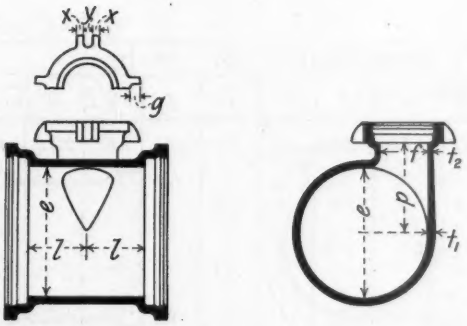
# Y Branches

Table No. 8 (concluded)

| Dimensions in Inches | | | | | | | | | | | Class | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nom. diam. e | f | s | p | v | w | n | r | $t_1$ | $t_2$ | $t_3$ | | |
| 18 | 18 | 18 | 30 | 12 | 14.7 | 1.17 | 30 | .75 | 1.08 | .75 | D | 1350 |
| " | " | " | " | " | " | 1.36 | " | .86 | 1.26 | .86 | F | 1490 |
| 20 | 20 | " | 34 | 13.5 | 16.4 | 1.25 | " | .79 | 1.15 | .79 | D | 1730 |
| " | " | " | " | " | " | 1.46 | " | .92 | 1.35 | .92 | F | 1940 |
| 24 | 18 | 9 | 30 | 12 | 14.7 | 1.17 | " | .88 | 1.08 | .75 | D | 1330 |
| " | " | " | " | " | " | 1.36 | " | 1.03 | 1.26 | .86 | F | 1490 |
| " | 20 | 12 | 34 | 13.5 | 16.4 | 1.25 | " | .88 | 1.15 | .79 | D | 1690 |
| " | " | " | " | " | " | 1.46 | " | 1.03 | 1.35 | .92 | F | 1900 |
| " | 24 | 18 | 38 | 15.25 | 19.3 | 1.35 | " | .88 | 1.25 | 88 | D | 2270 |
| " | " | " | " | " | " | 1.62 | " | 1.03 | 1.50 | 1.03 | F | 2600 |
| 30 | " | 12 | " | " | " | 1.35 | " | .81 | 1.25 | .88 | B | 2130 |
| " | " | " | " | " | " | 1.35 | " | 1.01 | 1.25 | .88 | D | 2250 |
| " | " | " | " | " | " | 1.62 | " | 1.20 | 1.50 | 1.03 | F | 2580 |
| " | 30 | 18 | 48 | 18 | 23.7 | 1.25 | " | .81 | 1.15 | .81 | B | 3130 |
| " | " | " | " | " | " | 1.57 | " | 1.01 | 1.45 | 1.01 | D | 3790 |
| " | " | " | " | " | " | 1.89 | " | 1.20 | 1.75 | 1.20 | F | 4420 |
| 36 | " | 10 | " | " | " | 1.25 | " | .90 | 1.15 | .81 | B | 3000 |
| " | " | " | " | " | " | 1.57 | " | 1.13 | 1.45 | 1.01 | D | 3640 |
| " | " | " | " | " | " | 1.89 | " | 1.37 | 1.75 | 1.20 | F | 4260 |
| " | 36 | 18 | 54 | 21 | 28.2 | 1.41 | 24 | .90 | 1.30 | .90 | B | 4480 |
| " | " | " | " | " | " | 1.79 | " | 1.13 | 1.65 | 1.13 | D | 5500 |
| " | " | " | " | " | " | 2.16 | " | 1.37 | 2.00 | 1.37 | F | 6400 |
| 42 | 30 | 6 | 48 | 18 | 23.7 | 1.25 | 30 | 1.00 | 1.15 | .81 | B | 3020 |
| " | " | " | " | " | " | 1.57 | " | 1.27 | 1.45 | 1.01 | D | 3620 |
| " | " | " | " | " | " | 1.89 | " | 1.53 | 1.75 | 1.20 | F | 4230 |
| " | 36 | 10 | 54 | 21 | 28.2 | 1.41 | 24 | 1.00 | 1.30 | .90 | B | 4320 |
| " | " | " | " | " | " | 1.79 | " | 1.27 | 1.65 | 1.13 | D | 5250 |
| " | " | " | " | " | " | 2.16 | " | 1.53 | 2.00 | 1.37 | F | 6140 |
| " | 42 | 18 | 60 | 25 | 33.1 | 1.62 | " | 1.00 | 1.50 | 1.00 | B | 6280 |
| " | " | " | " | " | " | 1.95 | " | 1.27 | 1.80 | 1.27 | D | 7520 |
| " | " | " | " | " | " | 2.44 | " | 1.53 | 2.25 | 1.53 | F | 8950 |
| 48 | 36 | 2 | 54 | 21 | 28.2 | 1.41 | " | 1.10 | 1.30 | .90 | B | 4090 |
| " | " | " | " | " | " | 1.79 | " | 1.40 | 1.65 | 1.13 | D | 4950 |
| " | " | " | " | " | " | 2.16 | " | 1.70 | 2.00 | 1.37 | F | 5790 |
| " | 42 | 10 | 60 | 25 | 33.1 | 1.62 | " | 1.10 | 1.50 | 1.00 | B | 6060 |
| " | " | " | " | " | " | 1.95 | " | 1.40 | 1.80 | 1.27 | D | 7230 |
| " | " | " | " | " | " | 2.44 | " | 1.70 | 2.25 | 1.53 | F | 8600 |
| " | 48 | 18 | 68.5 | 28 | 37.6 | 1.79 | " | 1.10 | 1.65 | 1.10 | B | 8570 |
| " | " | " | " | " | " | 2.22 | " | 1.40 | 2.05 | 1.40 | D | 10400 |
| " | " | " | " | " | " | 2.76 | " | 1.70 | 2.55 | 1.70 | F | 12450 |

Table No. 9

# Blow-off. Branches




| Dimensions in Inches | | | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Nom. diam. | | $l$ | $p$ | $t_1$ | $t_2$ | $x$ | $y$ | $g$ | Class | |
| $e$ | $f$ | | | | | | | | | |
| 8 | 4 | 12 | 7 | .63 | .48 | | | | I | 230 |
| 10 | " | " | 8 | .70 | " | | | | H | 295 |
| " | 6 | " | " | " | .54 | | | | " | 305 |
| 12 | 4 | " | 10 | .77 | .48 | | | | " | 375 |
| " | 6 | " | " | " | .54 | | | | " | 385 |
| 14 | 4 | " | 11 | .83 | .48 | | | | " | 455 |
| " | 6 | " | " | " | .54 | | | | " | 470 |
| 16 | 4 | " | 12 | .90 | .48 | | | | " | 580 |
| " | 6 | " | " | " | .54 | | | | " | 590 |
| 18 | 4 | " | 13 | .75 | .48 | | | | D | 600 |
| " | " | " | " | .86 | " | | | | F | 650 |
| " | 6 | " | " | .75 | .54 | | | | D | 610 |
| " | " | " | " | .86 | " | | | | F | 655 |
| 20 | 4 | " | 14 | .79 | .48 | | | | D | 695 |
| " | " | " | " | .92 | " | | | | F | 755 |
| " | 6 | " | " | .79 | .54 | | | | D | 700 |
| " | " | " | " | .92 | " | | | | F | 765 |
| 24 | " | " | 16 | .88 | " | | | | D | 915 |
| " | " | " | " | 1.03 | " | | | | F | 1000 |
| " | 8 | " | " | .88 | .63 | | | | D | 925 |
| " | " | " | " | 1.03 | " | | | | F | 1010 |
| 30 | " | 13 | 20 | .81 | " | | | | B | 1190 |
| " | " | " | " | 1.01 | " | | | | D | 1330 |
| " | " | " | " | 1.20 | " | | | | F | 1470 |

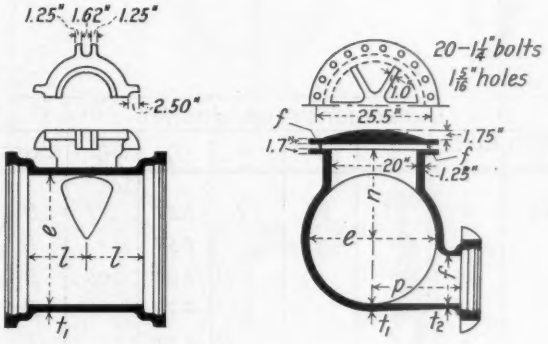
*Table No. 9*
*(concluded)*

# Blow-off Branches

| Dimensions in Inches | | | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Nom. diam. | | $l$ | $p$ | $t_1$ | $t_2$ | $x$ | $y$ | $g$ | Class | |
| $e$ | $f$ | | | | | | | | | |
| 30 | 12 | 13 | 20 | .81 | .77 | 1.25 | 1.62 | 2.50 | B | 1260 |
| " | " | " | " | 1.01 | " | " | " | " | D | 1390 |
| " | " | " | " | 1.20 | " | " | " | " | F | 1530 |
| 36 | 8 | " | 23 | .90 | .63 | | | | B | 1550 |
| " | " | " | " | 1.13 | " | | | | D | 1750 |
| " | " | " | " | 1.37 | " | | | | F | 1950 |
| " | 12 | " | " | .90 | .77 | " | " | " | B | 1610 |
| " | " | " | " | 1.13 | " | " | " | " | D | 1810 |
| " | " | " | " | 1.37 | " | " | " | " | F | 2010 |
| 42 | " | 15 | 26 | 1.00 | " | " | " | " | B | 2220 |
| " | " | " | " | 1.27 | " | " | " | " | D | 2510 |
| " | " | " | " | 1.53 | " | " | " | " | F | 2810 |
| " | 16 | " | " | 1.00 | .90 | " | " | " | B | 2290 |
| " | " | " | " | 1.27 | " | " | " | " | D | 2580 |
| " | " | " | " | 1.53 | " | " | " | " | F | 2870 |
| 48 | 12 | 17 | 30 | 1.10 | .77 | " | " | " | B | 2920 |
| " | " | " | " | 1.40 | " | " | " | " | D | 3360 |
| " | " | " | " | 1.70 | " | " | " | " | F | 3790 |
| " | 16 | " | " | 1.10 | .90 | " | " | " | B | 3000 |
| " | " | " | " | 1.40 | " | " | " | " | D | 3420 |
| " | " | " | " | 1.70 | " | " | " | " | F | 3850 |
| 54 | 12 | 19 | 33 | 1.20 | .77 | " | " | " | B | 3870 |
| " | " | " | " | 1.54 | " | " | " | " | D | 4490 |
| " | " | " | " | 1.90 | " | " | " | " | F | 5530 |
| " | 16 | " | " | 1.20 | .90 | " | " | " | B | 3950 |
| " | " | " | " | 1.54 | " | " | " | " | D | 4560 |
| " | " | " | " | 1.90 | " | " | " | " | F | 5580 |
| 60 | 12 | 21 | 36 | 1.30 | .77 | " | " | " | B | 4850 |
| " | " | " | " | 1.70 | " | " | " | " | D | 5740 |
| " | " | " | " | 2.10 | " | " | " | " | F | 7080 |
| " | 16 | " | " | 1.30 | .90 | " | " | " | B | 4930 |
| " | " | " | " | 1.70 | " | " | " | " | D | 5810 |
| " | " | " | " | 2.10 | " | " | " | " | F | 7130 |

Table No. 10

# Blow-off Branches
## with Manholes




| Dimensions in Inches | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|
| Nom. diam. e | f | l | p | n | $t_1$ | $t_2$ | Class | |
| 30 | 8 | 17 | 20 | 21 | .81 | .63 | B | 1880 |
| " | " | " | " | " | 1.01 | " | D | 2040 |
| " | " | " | " | " | 1.20 | " | F | 2190 |
| " | 12 | " | " | " | .81 | .77 | B | 1940 |
| " | " | " | " | " | 1.01 | " | D | 2100 |
| " | " | " | " | " | 1.20 | " | F | 2250 |
| 36 | 8 | " | 23 | 24 | .90 | .63 | B | 2270 |
| " | " | " | " | " | 1.13 | " | D | 2500 |
| " | " | " | " | " | 1.37 | " | F | 2740 |
| " | 12 | " | " | " | .90 | .77 | B | 2340 |
| " | " | " | " | " | 1.13 | " | D | 2560 |
| " | " | " | " | " | 1.37 | " | F | 2800 |
| 42 | " | " | 26 | 27 | 1.00 | " | B | 2850 |

*Table No. 10*
*(concluded)*

# Blow-off Branches
## with Manholes

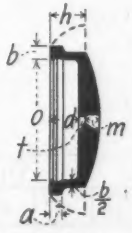
| Dimensions in Inches | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|
| Nom. diam. | | $l$ | $p$ | $n$ | $t_1$ | $t_2$ | Class | |
| $e$ | $f$ | | | | | | | |
| 42 | 12 | 17 | 26 | 27 | 1.27 | .77 | D | 3160 |
| " | " | " | " | " | 1.53 | " | F | 3460 |
| " | 16 | " | " | " | 1.00 | .90 | B | 2930 |
| " | " | " | " | " | 1.27 | " | D | 3220 |
| " | " | " | " | " | 1.53 | " | F | 3520 |
| 48 | 12 | " | 30 | 30 | 1.10 | .77 | B | 3400 |
| " | " | " | " | " | 1.40 | " | D | 3800 |
| " | " | " | " | " | 1.70 | " | F | 4200 |
| " | 16 | " | " | " | 1.10 | .90 | B | 3480 |
| " | " | " | " | " | 1.40 | " | D | 3870 |
| " | " | " | " | " | 1.70 | " | F | 4260 |
| 54 | 12 | 19 | 33 | 33 | 1.20 | .77 | B | 4330 |
| " | " | " | " | " | 1.54 | " | D | 4920 |
| " | " | " | " | " | 1.90 | " | F | 5920 |
| " | 16 | " | " | " | 1.20 | .90 | B | 4410 |
| " | " | " | " | " | 1.54 | " | D | 4980 |
| " | " | " | " | " | 1.90 | " | F | 5970 |
| 60 | 12 | 21 | 36 | 36 | 1.30 | .77 | B | 5300 |
| " | " | " | " | " | 1.70 | " | D | 6150 |
| " | " | " | " | " | 2.10 | " | F | 7450 |
| " | 16 | " | " | " | 1.30 | 90 | B | 5380 |
| " | " | " | " | " | 1.70 | " | D | 6220 |
| " | " | " | " | " | 2.10 | " | F | 7500 |

# Caps

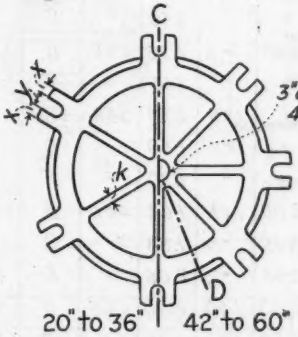
Table No. 14

12" & 14" 16" & 18"

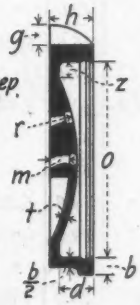
4" to 10"




A-B




20" to 36" 42" to 60"




C-D

"a" and "b" as tabulated in Table No. 1

g = 2.50" for 12" to 24" incl. g = 3.00" for 30" to 60" incl.

x = 1.25" " " " " " x = 1.50" " " " " "

y = 1.62" " " " " " y = 2.00" " " " " "

| Nom. diam. | Dimensions in Inches | | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| | d | o | h | t | m | k | z | r | Class | |
| 4 | 3.0 | 5.7 | 3.60 | .60 | | | | | K | 25 |
| 6 | " | 7.8 | 3.65 | .65 | | | | | I | 40 |
| 8 | 3.5 | 10.0 | 4.25 | .75 | | | | | I | 60 |
| 10 | " | 12.1 | " | " | 1.50 | .75 | | 16.2 | H | 80 |
| 12 | " | 14.2 | " | " | 1.75 | " | | 18.7 | " | 135 |
| 14 | " | 16.35 | 4.40 | .90 | 1.90 | " | | 22.4 | " | 175 |
| 16 | 4.0 | 18.6 | 5.00 | 1.00 | 2.00 | " | | 27.0 | " | 240 |
| 18 | " | 20.4 | " | " | " | 1.00 | | 32.0 | D | 280 |
| " | " | 20.7 | " | " | " | " | | 32.9 | F | 285 |

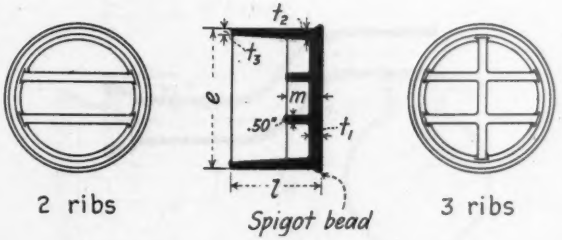
Table No. 14
(concluded)

# Caps

| Dimensions in Inches | | | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|
| Nom. diam. | d | o | h | t | m | k | z | r | Class | |
| 20 | 4.0 | 22.5 | 5.00 | 1.00 | 3.00 | 1.00 | 1.25 | 18.2 | D | 330 |
| " | " | 23.0 | " | " | " | " | 1.50 | " | F | 350 |
| 24 | " | 26.6 | 5.25 | 1.05 | 3.50 | " | 1.30 | 23.5 | D | 450 |
| " | " | 27.1 | " | " | " | " | 1.55 | " | F | 470 |
| 30 | 4.5 | 32.6 | 5.75 | 1.15 | " | 1.15 | 1.30 | 34.8 | B | 650 |
| " | " | 33.0 | " | " | " | " | 1.50 | " | D | 675 |
| " | " | 33.4 | " | " | " | " | 1.70 | " | F | 700 |
| 36 | " | 38.8 | 6.00 | 1.25 | 4.00 | 1.25 | 1.63 | 44.0 | B | 940 |
| " | " | 39.3 | " | 1.30 | 3.95 | " | 1.88 | " | D | 970 |
| " | " | 39.7 | " | 1.35 | 3.90 | " | 2.08 | " | F | 1000 |
| 42 | 5.0 | 45.0 | 7.00 | 1.40 | 4.00 | 1.40 | 2.00 | 63.5 | B | 1400 |
| " | " | 45.5 | " | 1.50 | 3.90 | " | 2.25 | " | D | 1450 |
| " | " | 46.1 | " | 1.60 | 3.80 | " | 2.55 | " | F | 1520 |
| 48 | " | 51.2 | " | 1.70 | 4.00 | 1.50 | 2.10 | 76.5 | B | 1900 |
| " | " | 51.8 | " | 1.90 | 3.80 | " | 2.40 | " | D | 2000 |
| " | " | 52.4 | " | 2.00 | 3.70 | " | 2.70 | " | F | 2100 |
| 54 | 5.5 | 57.4 | 7.50 | 1.90 | 4.50 | " | 2.20 | 82.0 | B | 2550 |
| 60 | " | 63.6 | " | 2.00 | " | " | 2.30 | 99.0 | B | 3100 |

Table No. 15

# Plugs




2 ribs

Spigot bead

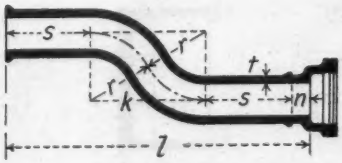
3 ribs

e = actual outside diam., Table No. 1

| Dimensions in Inches | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|
| Nom. diam | l | m | No. of ribs | $t_1$ | $t_2$ | $t_3$ | Class | |
| 4 | 5.5 | | | .50 | .40 | .20 | K | 10 |
| 6 | " | | | .60 | " | " | I | 15 |
| 8 | " | 2.0 | 2 | " | " | " | " | 25 |
| 10 | 6.0 | " | " | .70 | .50 | " | H | 40 |
| 12 | " | " | " | .75 | " | " | " | 55 |
| 14 | " | " | " | " | " | " | " | 65 |
| 16 | 6.5 | " | 3 | " | .60 | .30 | " | 90 |
| 18 | " | 2.50 | " | " | " | " | F | 110 |
| 20 | " | 2.75 | " | 1.00 | " | " | " | 155 |

Table No. 16

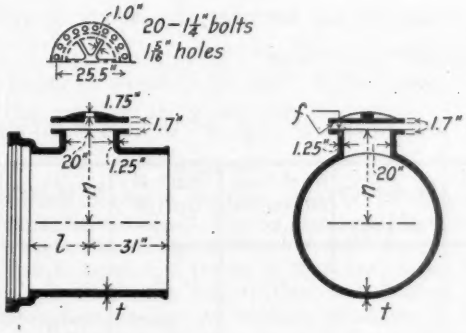
# Offsets




| Dimensions in Inches | | | | | | | | Weight |
|---|---|---|---|---|---|---|---|---|
| Nom. diam | n | s | k | l | r | t | Class | |
| 4 | 2 | 10 | 13.85 | 35.85 | 8 | .48 | K | 95 |
| 6 | " | " | 24.25 | 46.25 | 14 | .54 | I | 185 |
| 8 | " | " | 26.00 | 48.00 | 15 | .63 | I | 290 |
| 10 | " | " | 27.70 | 49.70 | 16 | .70 | H | 405 |
| 12 | " | " | 29.45 | 51.45 | 17 | .77 | " | 540 |
| 14 | " | " | 31.20 | 53.20 | 18 | .83 | " | 700 |
| 16 | " | " | 32.90 | 54.90 | 19 | .90 | " | 900 |

Table No. 17

# Manhole Pipes




| Dimensions in Inches | | | | | Weight | Dimensions in Inches | | | | | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nom. Diam. | l | n | t | Class | | Nom. Diam. | l | n | t | Class | |
| 30 | 17 | 21 | .81 | B | 1790 | 48 | 17 | 30 | 1.10 | B | 3220 |
| " | " | " | 1.01 | D | 2020 | " | " | " | 1.40 | D | 3790 |
| " | " | " | 1.20 | F | 2250 | " | " | " | 1.70 | F | 4370 |
| 36 | " | 24 | .90 | B | 2190 | 54 | 19 | 33 | 1.20 | B | 3980 |
| " | " | " | 1.13 | D | 2520 | " | " | " | 1.54 | D | 4750 |
| " | " | " | 1.37 | F | 2850 | " | " | " | 1.90 | F | 5760 |
| 42 | " | 27 | 1.00 | B | 2680 | 60 | 21 | 36 | 1.30 | B | 4800 |
| " | " | " | 1.27 | D | 3130 | " | " | " | 1.70 | D | 5840 |
| " | " | " | 1.53 | F | 3570 | " | " | " | 2.10 | F | 7120 |

## Note regarding Lugs on Branches

*Lugs of the form and dimensions given in the preceding tables are to be placed on the bells of side outlets on all branches, on outlets 12 inches in diameter and larger.*

Number and Weight of Lugs on Outlets of different sizes

| Diam. of Outlet Ins. | No. of Pairs of Lugs | Wt. of Lugs on one bell. Lbs. | Diam. of Outlet Ins. | No. of Pairs of Lugs | Wt. of Lugs on one bell. Lbs. |
|---|---|---|---|---|---|
| 12 | 4 | 32 | 36 | 6 | 80 |
| 14 | " | " | 42 | 8 | 111 |
| 16 | 6 | 56 | 48 | " | 114 |
| 18 | " | " | 54 Class D | " | 126 |
| 20 | " | " | " " F | " | 134 |
| 24 | " | " | 60 " D | " | 129 |
| 30 | " | 80 | " " F | " | 137 |

*Two pairs of lugs to be placed on the vertical axis of each bell the others to be spaced at equal distances around the circumference.*

*If branches are made without lugs the standard weights given in the tables should be reduced in accordance with the weights given above.*

# PROCEEDINGS.

## December Meeting.

Hotel Brunswick,
Boston, Mass., December 10, 1902.

President Frank E. Merrill in the chair; Willard Kent, Secretary. The following members and guests were present: —

### Members.

Frank A. Andrews, Charles H. Baldwin, Lewis M. Bancroft, Frank A. Barbour, Joseph E. Beals, James F. Bigelow, George F. Chace, E. J. Chadbourne, G. L. Chapin, John C. Chase, William F. Codd, Freeman C. Coffin, R. C. P. Coggeshall, Leonard S. Doten, B. R. Felton, Albert S. Glover, W. J. Goldthwait, E. H. Gowing, John O. Hall, T. G. Hazard, Jr., E. J. Johnson, Willard Kent, George A. Kimball, Theodore H. McKenzie, Henry V. Macksey, William E. Maybury, Frank E. Merrill, Dwight Porter, William B. Sherman, Sidney Smith, George H. Snell, Lucian A. Taylor, William H. Thomas, W. H. Vaughn, Charles K. Walker, George E. Wilde, Frank B. Wilkins, Frederic I. Winslow, George E. Winslow. — 39.

### Associates.

Chapman Valve Mfg. Co., by Edward F. Hughes; Coffin Valve Co., by H. L. Weston; William V. Briggs; Hersey Mfg. Co., by Albert S. Glover and James A. Tilden; Lamb & Ritchie, by Harry F. Peck; Lead Lined Iron Pipe Co., by Thomas E. Dwyer; Ludlow Valve Mfg. Co., by H. F. Gould and S. F. Ferguson; A. W. Chesterton Co., by W. H. Greenwood; National Meter Co., by Charles H. Baldwin and J. G. Lufkin; Neptune Meter Co., by H. H. Kinsey; Perrin, Seamans & Co., by James C. Campbell; Rensselaer Mfg. Co., by Fred S. Bates; A. P. Smith Mfg. Co., by W. H. Van Winkle; Thomson Meter Co., by S. D. Higley; Union Water Meter Co., by J. P. K. Otis; United States Cast Iron Pipe and Foundry Co., by W. B. Franklin. —19.

### Guests.

J. J. Moore, Hingham; Edward Atkinson, President Boston Manufacturers Mutual Fire Insurance Co., Boston, Mass.; D. E. Makepeace, Water Commissioner, Attleboro, Mass.; Charles M. Robbins, Chairman Board Park Commissioners, Attleboro, Mass.; William A. Tucker, New Bedford, Mass. — 5.

[Names counted twice — 2.]

The Secretary submitted the following applications for membership, the same having been duly approved by the Executive Committee: —

*For Resident Member.*

D. E. Makepeace, Water Commissioner, Attleboro, Mass.; W. C. Perkins, Brookline, Mass., Hydraulic Engineer, formerly in charge of water works in Berlin, N. H.; George E. Bolling, Chemist and Bacteriologist in charge of sewage disposal works, Brockton, Mass.; Frank H. Golding, Superintendent Bradford Water and Lighting Company, Bradford, Conn.

*For Non-Resident Member.*

Alfred Douglass Flinn, Managing Editor, *Engineering Record*, New York City; David J. Howell, Washington, D. C., engaged in preparing plans for new reservoir for Alexandria Water Company, Alexandria, Va.

On motion of Mr. Bancroft, the Secretary was directed to cast one ballot in favor of the applicants, after which they were declared elected to membership.

Edward Atkinson, president of the Boston Manufacturers Mutual Fire Insurance Company, read a paper entitled "The Relation of Water Works Engineers to the Fire Service of Factories." The subject was discussed by Charles K. Walker, of Manchester, N. H.; George H. Snell, of Attleboro; Walter H. Richards, of New London, Conn.; Theodore H. McKenzie, of Southington, Conn.; R. C. P. Coggeshall, of New Bedford; Henry V. Macksey, of Boston; George F. Chace, of Taunton; and John C. Chase, of Derry, N. H. Mr. Atkinson then spoke in reply to criticisms which the discussion had brought out.

Mr. William B. Sherman, of Providence, R. I., gave a talk on "Practical and Theoretical Precision in Everyday Life." Edward Atkinson, of Boston, and Freeman C. Coffin, of Boston, also spoke.

Adjourned.

# PROCEEDINGS.

## Annual Meeting.

Hotel Brunswick,
Boston, January 14, 1903.

President Merrill in the chair; Willard Kent, Secretary.

The following members and guests were present: —

### Members.

E. W. Bailey, C. H. Baldwin, L. M. Bancroft, J. E. Beals, J. F. Bigelow, J. W. Blackmer, George Bowers, Dexter Brackett, E. C. Brooks, Fred Brooks, A. W. F. Brown, G. A. P. Bucknam, G. F. Chace, J. C. Chase, W. R. Conard, R. C. P. Coggeshall, M. F. Collins, H. A. Cook, F. H. Crandall, J. W. Crawford, A. O. Doane, J. N. Ferguson, A. D. Flinn, Albert S. Glover, J. A. Gould, F. W. Gow, E. H. Gowing, C. E. Haberstroh, J. O. Hall, J. C. Hammond, Jr., G. H. Hart, J. D. Hardy, G. W. Harrington, V. C. Hastings, L. E. Hawes, Allen Hazen, D. A. Heffernan, H. G. Holden, J. William Kay, E. W. Kent, Willard Kent, F. C. Kimball, E. S. Larned, J. W. Locke, T. H. McKenzie, Thomas McKenzie, A. E. Martin, William E. Maybury, F. E. Merrill, H. A. Miller, F. L. Northrop, W. W. Patch, Dwight Porter, C. W. Sherman, J. Waldo Smith, G. H. Snell, G. A. Stacy, J. J. Sullivan, L. A. Taylor, R. J. Thomas, W. H. Thomas, W. H. Vaughn, C. K. Walker, R. S. Weston, F. B. Wilkins, G. E. Winslow, E. T. Wiswall, L. R. Woods. — 68.

### Associates.

Builders Iron Foundry, by F. N. Connet; Chapman Valve Mfg. Co., by Edward F. Hughes; Chas. A. Claflin & Co., by Charles A. Claflin; Coffin Valve Co., by H. L. Weston; William V. Briggs; Eagle Oil & Supply Co., by C. N. Goword; William H. Gallison Co., by H. E. Stilphen; Hersey Mfg. Co., by Albert S. Glover; Henry F. Jenks; Lead Lined Iron Pipe Co., by Thomas E. Dwyer; Ludlow Valve Mfg. Co., by H. F. Gould; H. Mueller Mfg. Co., by Fred B. Mueller; National Meter Co., by Charles H. Baldwin and J. G. Lufkin; Neptune Meter Co., by H. H. Kinsey; Rensselaer Mfg. Co., by Fred S. Bates; Ross Valve Co., by William Ross; A. P. Smith Mfg. Co., by Anthony P. Smith; Thomson Meter Co., by S. D. Higley; Union Water Meter Co., by F. L. Northrop; Stilwell-Bierce & Smith-Vaile Co., by F. H. Hayes.—21.

GUESTS.

John W. Churchill, Water Commissioner, Plymouth, Mass.; Charles W. Shippee, President Milford Water Co., Milford, Mass.; F. Herbert Snow, Boston, Mass.; Walter T. Littlefield, Somerville, Mass.; S. A. Agnew, Superintendent Scituate Water Works, Scituate, Mass.; Mr. Gregory, Paterson, N. J.; Charles L. Parmelee, New York City; A. H. Robinson. Lowell, Mass. — 8.
(Names counted twice — 3.)

The President appointed Messrs. George E. Winslow and Thomas McKenzie as tellers to count the ballots for officers.

The following new members were elected: —

*Resident.*

Courtland E. Colver, Groton, Conn., Superintendent Groton Water Co.; Samuel A. Agnew, North Scituate, Superintendent Scituate Water Works; John W. Churchill, Plymouth, Water Commissioner; Fred F. Moore, Civil Engineer Metropolitan Water Works, Boston, Mass.

*Non-Resident.*

E. H. Foster, New York, Consulting Engineer and Water Works Expert; Percival M. Churchill, Assistant Hydrographer United States Geological Survey, Washington; and William Volkhardt, Superintendent Crystal Water Co., Stapleton, N. Y.

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President Frank E. Merrill then delivered the following address:

## PRESIDENT MERRILL'S ADDRESS.

*Gentlemen of the New England Water Works Association,* — Once more time, in its onward flight, has rolled off its cycle of the seasons, and we gather again in our annual meeting to review our accomplishments of the past year and to take up with new life and vigor the duties that lie before us.

The enviable position which we have attained as a professional association will act as an incentive to continued effort on the part of both officers and members to see that there shall be no retrogression.

Harmony and progress go hand in hand; and who shall deny that it is largely due to the absence of discordant elements in our organization that we have been enabled to attain the signal success that is so

FRANK E. MERRILL,
President of the New England Water Works Association,
1902.

unstintingly accorded the New England Water Works Association? I deem it a privilege to pay tribute to the spirit of good-fellowship which has pervaded all our work of the past year, and to express my appreciation of your hearty support and coöperation, factors which are so essential to the successful administration of any officer who aspires to produce results.

The grim reaper has again entered our ranks, and I have to record the death of five of our members, reported since our last meeting.

Mr. William Downey, general foreman of the outside work of the Worcester, Mass., Water Department, died October 1, 1901. He was elected a member of this Association June 14, 1899.

Mr. Cyrus B. Martin, Treasurer of the water company, Norwich, N. Y., died April 2, 1902. Mr. Martin was one of the older members of this Association, having joined on June 17, 1887.

Mr. Joseph C. Hancock, Superintendent of Water Works at Springfield, Mass., for thirty-eight years, died on July 12. Mr. Hancock was one of the original members of our Association. He attended the preliminary meeting held on April 19, 1882, and his membership dates from the founding of the Association, June 21, 1882.

Mr. Frank E. Fuller, an engineer on the Metropolitan Water Works, died August 1, at Santa Cruz, on the far island of Teneriffe, whither he had gone in pursuit of health. Mr. Fuller became a member of our Association March 14, 1900.

Mr. George A. Hotchkin, Superintendent of the Bureau of Water, Rochester, N. Y., died in that city October 6. Mr. Hotchkin had been connected with the Rochester Water Works for many years, and was elected a member of our Association on June 13, 1900.

When emerging from the period of youth into manhood, one naturally, perhaps, becomes retrospective, and we will be pardoned, therefore, as we approach the close of our twenty-first year of associate life, for glancing backward for a moment in review of our growth in numbers and in financial strength. The items which follow have been gathered from the records of the Association, and have been tabulated for the purpose of having them in convenient form for reference in the future:

## NEW ENGLAND WATER WORKS ASSOCIATION.

| YEAR. | PRESIDENT. | MEMBERSHIP. | | | | ANNUAL CONVENTION. | | RECEIPTS | EXPENDITURES. | CASH BALANCE. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | MEMBERS. | ASSOCIATE. | HONORARY. | TOTAL. | PLACE. | DATE. | | | |
| 1882 | (Organized) | 27 | — | — | 27 | Boston, Mass. | June 21, '82 | | | |
| 1882–3 | * James W. Lyon | 37 | 6 | — | 43 | Worcester, Mass. | June 21, '83 | $ 245.00 | $ 87.86 | $ 157.14 |
| 1883–4 | Frank E. Hall | 48 | 9 | — | 57 | Lowell, Mass. | June 19–20, '84 | 156.14 | 171.90 | 141.38 |
| 1884–5 | George A. Ellis | 83 | 44 | — | 127 | Springfield, Mass. | June 18–19, '85 | 651.84 | 511.44 | 281.78 |
| 1885–6 | R. C. P. Coggeshall | 106 | 47 | — | 153 | New Bedford, Mass. | June 16–18, '86 | 1 658.50 | 1 643.42 | 296.86 |
| 1886–7 | * Henry W. Rogers | 137 | 52 | 2 | 191 | Manchester, N. H. | June 15–17, '87 | 1 342.28 | 1 066.98 | 572.16 |
| 1887–8 | * Edwin Darling | 181 | 54 | 3 | 238 | Providence, R. I. | June 13–15, '88 | 2 013.30 | 1 697.15 | 888.31 |
| 1888–9 | * Hiram Nevons | 209 | 64 | 4 | 277 | Fall River, Mass. | June 12–14, '89 | 2 204.07 | 2 127.70 | 964.68 |
| 1889–90 | Dexter Brackett | 257 | 73 | 5 | 335 | Portland, Me. | June 11–13, '90 | 2 511.27 | 2 346.65 | 1 129.30 |
| 1890–1 | * Albert F. Noyes | 281 | 74 | 5 | 360 | Hartford, Conn. | June 10–12, '91 | 3 055.13 | 1 884.78 | 2 299.65 |
| 1891–2 | Horace G. Holden | 290 | 70 | 5 | 365 | Holyoke, Mass. | June 8–10, '92 | 2 887.17 | 3 278.54 | 1 908.28 |
| 1892–3 | George F. Chace | 338 | 69 | 5 | 412 | Worcester, Mass. | June 14–16, '93 | 3 422.61 | 3 317.22 | 2 013.67 |
| 1893–4 | * Geo. E. Batchelder | 365 | 73 | 5 | 443 | Boston, Mass. | June 14–16, '94 | 3 208.85 | 3 259.07 | 1 963.45 |
| 1894–5 | George A. Stacy | 401 | 81 | 5 | 487 | Burlington, Vt. | Sept. 11–13, '95 | 3 147.41 | 3 115.99 | 2 673.03 |
| 1895–6 | Desmond FitzGerald | 442 | 82 | 5 | 529 | Lynn, Mass. | June 10–12, '96 | 3 179.91 | 3 148.49 | 2 704.45 |
| 1896–7 | * John C. Haskell | 464 | 80 | 5 | 549 | Newport, R. I. | Sept. 8–10, '97 | 3 340.23 | 3 322.94 | 2 721.74 |
| 1897–8 | Willard Kent | 488 | 77 | 5 | 570 | Portsmouth, N. H. | Sept. 14–16, '98 | 3 002.13 | 2 786.95 | 2 936.92 |
| 1898–9 | Fayette F. Forbes | 494 | 73 | 5 | 572 | Syracuse, N. Y. | Sept. 13–15, '99 | 2 825.71 | 3 050.23 | 2 712.40 |
| 1899–1900 | Byron I. Cook | 519 | 70 | 5 | 594 | Rutland, Vt. | Sept. 19–20, '00 | 4 920.49 | 5 524.65 | 2 108.24 |
| 1901 | Frank H. Crandall | 493 | 58 | 4 | 555 | Portland, Me. | Sept. 18–20, '01 | 4 238.55 | 4 283.22 | 2 063.57 |
| 1902 | Frank E. Merrill | 522 | 60 | 5 | 587 | Boston, Mass. | Sept. 10–12, '02 | 5 158.48 | 4 680.32 | 2 541.73 |

*Deceased.

From this table it is apparent that the New England Water Works Association is to-day on an eminently satisfactory basis both numerically and financially.

Our membership has shown a healthy growth during the past year. Sixty-six names have been added to our roll, 5 members have died, 14 have resigned, and 15 have been dropped for non-payment of dues; the net increase being 32. The total membership is now 587, and comprises 522 members, 60 associates, and 5 honorary members.

The finances of our Association are in a very satisfactory condition, and the funds continue well guarded by Treasurer Bancroft.

Our receipts have been $5 158.48 and our expenses have amounted to $4 680.32, so that, notwithstanding several extraordinary expenditures, our payments have kept well within our receipts and all bills have been paid, so that there are no accounts outstanding against us.

The balance in our treasury at the beginning of the year was $2 063.57 and at the close we show a balance of $2 541.73, a gain for the year of $478.16, or more than twenty-two per cent.

Our present financial standing may be stated as follows: —

| *Assets.* | | *Liabilities.* | |
|---|---|---|---|
| Cash in Treasury | $2 541.73 | Accounts Payable | $0 000.00 |
| Uncollected Advertisements | 662.50 | Excess of Assets over Liabilities | 4 065.86 |
| Uncollected Dues | 592.10 | | |
| Sundry Uncollected Accounts | 19.53 | | |
| Office Furniture, value, | 250.00 | | |
| Total | $4 065.86 | Total | $4 065.86 |

In addition to the above we have an excellent library that is constantly increasing in value.

Details of interest are presented in the reports of the Secretary, Treasurer and Editor, which I commend to your careful attention.

The personnel of our membership continues to be our pride; the interest in our work during the year has suffered no diminution; the attendance at our meetings has been well sustained, and the papers presented have been especially instructive and helpful.

Meetings have been held as follows: —

January 8. Annual meeting at Young's Hotel. Attendance 73.

February 12. Monthly meeting at Young's Hotel. Attendance 106.

March 12. Monthly meeting at Young's Hotel. Attendance 76.

June 25. Annual field day. This meeting was devoted to a most enjoyable excursion down Boston Harbor, by special steamboat, a shore dinner at Nantasket Point Hotel, and a very interesting visit to the works of the Fore River Ship and Engine Company in Quincy. The number participating in this excursion was 174.

September 10, 11, 12. Annual convention in Boston, with headquarters at Hotel Brunswick, Copley Square. Business meetings were held in the morning and afternoon of September 10, with an illustrated lecture in the evening by Mr. Frederic P. Stearns, chief engineer Metropolitan Water Works, on recent progress in the construction of the works under his charge.

On the 11th, meetings were again held in the morning and afternoon, and in the evening Past-President Desmond FitzGerald entertained a large audience with an illustrated talk on "What an Engineer Saw in Venice." At these sessions interesting papers were presented by other members of the Association, which appear in the pages of the JOURNAL.

On Friday, September 12, an excursion was made to the Metropolitan Water Works, visiting the work in progress in Clinton, Wayland, and Weston. The trip was made especially enjoyable to the 135 members who composed the party through courtesies extended by the Boston & Maine Railroad Company and the Metropolitan Water and Sewerage Board. The registered attendance at the meetings of this convention was 291.

The associate members displayed one of their best and most interesting exhibits of water-works appliances, and rendered valuable assistance in making this a most successful convention.

November 12. Monthly meeting at Hotel Brunswick. Attendance 67.

December 10. Monthly meeting at Hotel Brunswick. Attendance 56.

The December meeting was held during a spell of extremely cold weather, which undoubtedly accounts for the small attendance.

The proceedings of the past year have been signalized by the reports of two committees that have had under consideration matters of much interest in water-works practice. First in importance is

that of the Committee on Standard Specifications for Cast Iron Pipe, and much credit should be awarded this committee for the thoroughness which characterized their consideration of the various matters involved in this question. The results promise to be of great and lasting benefit in the construction of water works through a standardization of pipes and specials.

Next was the report of the Committee on Uniform Statistics. This committee presented a modification of the form heretofore in use for water-works statistics, which met with the approval of this Association, and is likely to be generally adopted by the organizations having an interest in uniformity of municipal statistics.

The committee having under consideration the subject of "Apportionment of Charges for Private Fire Protection and the Means of Controlling the Supply Thereto" is also entitled to honorable mention for their effort to satisfactorily settle several vexed questions. Unfortunately they failed to bring in a unanimous report, and another committee has been formed to give further study to the subject.

It has been stated many times, but will bear repeating, that the object of our Association — namely, the exchange of knowledge pertaining to the construction and management of water works — should appeal to every official, of whatever title, who is responsible in any degree for the proper conduct of a water-works plant. It would be a good investment for every city, town, or company owning water works to be represented, *at its expense*, in the membership of this Association by at least one official; and then it should be seen to that so far as possible he attended the meetings.

A vast amount of good is obtained by the stay-at-home member of our Association through a perusal of the pages of our JOURNAL, but an even greater benefit is derived through the social intercourse and the exchange of ideas afforded by our meetings, the coming into personal contact with the masters of the profession, and the opportunity given here to listen to the words of wisdom born of experience, as they drop from the lips of the many eminent contributors to our valuable and increasing fund of information on water-works topics.

Your Executive Committee has given faithful attention to all the matters that have come before it, and a record of its doings is this year, for the first time, included in the several issues of the JOURNAL. One of the acts of this committee was to renew the lease of the Association headquarters in Tremont Temple for another term of three

years, and I wish to take this opportunity to urge you all to use these finely appointed rooms more freely than has been your custom. There you will find an efficient clerk to give you information, a valuable library for your researches, current magazines, stationery, and like conveniences, with ample room for business appointments or conferences. The privileges are yours, and it is for you to enjoy them.

In reference to our library I will add that we all have an opportunity here to benefit the Association by making such contributions as we can from time to time to the bookshelves.

Our JOURNAL is growing more valuable with each succeeding issue. I may safely say that the December number has not been equalled by any similar publication for the amount of practical and interesting matter within its covers. As the official publication of the foremost organization devoted to the interests of water works, it requires much time and editorial ability to bring it forth in the acceptable form in which it always comes to us, and you will agree with me in recognizing the eminent fitness for this work of our Editor, Mr. Sherman.

The card index which has so long been an object of desire as a complete reference to our JOURNAL contributions is soon to become a materialization, as your Executive Committee has authorized the assistance of expert indexers, who are now engaged in the work.

The value of an Advertising Agent has, I think, been apparent in the results shown by the work of Mr. Thomas. It seems desirable that the JOURNAL should be self-supporting. To accomplish this end, and to maintain the high standard of excellence to which the JOURNAL aspires, it is necessary that much attention be given the advertising department. The results of the past year, showing a net gain of three pages and a total advertising value for the year of $1 996, are certainly most gratifying. I can only urge that in return you will give to those concerns that favor the Association with their advertising patronage, all of whom are entirely reliable, all the encouragement you can by consulting them relative to such purchases as you may make. I will further suggest your making it known to them that your inquiries result from their advertisement in the JOURNAL.

The duties of Secretary of an organization like our own require the qualities of tact, energy and versatility. The New England Water Works Association always has been fortunate in its choice

of men to fill that position; much of its success, in fact, can be traced to the able services of such men as Coggeshall, Glover, and Whitney, who have honored this office in the past, and to their worthy successor, our present Secretary Kent.

The affairs of our Association appear to be in so altogether satisfactory a condition that there seems little left to be desired, yet it will not do for us to rest content with the success which we have achieved. There are opportunities before us to still further signalize our organization as a leader and authority in matters pertaining to water-works theories and practice. Such problems as conservation and protection of water supplies, equitable charges for water, methods of assessing and collecting water rates, financial relations between the water and other municipal departments, and kindred questions, are live and interesting subjects for your consideration, and if taken up in the meetings of this Association cannot fail to be of value as a record of the prevailing customs and sentiments in different municipalities, even if it is too much to hope that uniformity of policy may result therefrom.

The practical superintendent, the man of experience and ideas, who can tell us how best to lay and maintain a line or a system of water pipes and their various appurtenances, who knows how to straighten out the numerous kinks that are not mentioned in the books but are, nevertheless, so frequently in evidence in the management of a water-works plant, must not be allowed to remain in the background in the proceedings of our meetings; the water registrar, the trained office manager, with his intimate knowledge of water-works accounting and his wide experience with a critical public in matters connected with the monetary end of the business, must be prevailed upon to give up to us the secret of his successful office methods; the engineer and specialist must continue to give us the benefit of their technical training and the results of their researches along lines that appeal to us from a practical water-works standpoint.

The founders of our Association laid their work true to line and grade, and builded well; and now, in this later day, having the suitable material at our hand, it should not be difficult for us to properly dispose it and carry the structure along in a manner that will be a credit to the past, an honor to the present, and an inspiration to the future.

In retiring now, at the close of my term, from the high and honorable position to which you have seen fit to elevate me, a position to which my thoughts will ever turn with pride, I hand over to my successor the duties and burdens of the office, but shall hope to retain indefinitely that confidence which you have reposed in me and the good will and friendly spirit which you have always so generously manifested toward me.

I wish the Association and you individually a happy and prosperous year.

## REPORT OF THE SECRETARY.

The Secretary, Mr. Willard Kent, submitted the following report: —

*Mr. President and Gentlemen of the New England Water Works Association,* — I have the honor to submit the following report of membership, receipts, and disbursements of the New England Water Works Association for the year ending December 31, 1902: —

### MEMBERSHIP.

| | |
|---|---|
| The total membership of the Association, January 1, 1902 was | 555 |
| The present membership is | 587 |
| A net increase during the year of | 32 |

The membership is divided as follows: —

### MEMBERS.

| | | | |
|---|---|---|---|
| January 1, 1902. | Total Active Membership | | 493 |
| | Withdrawals: | | |
| | Resignations | 11 | |
| | Dropped | 12 | |
| | Died | 5 | |
| | Transferred | 1 | 29 |
| | | | 464 |
| | Initiations: | | |
| | January | 4 | |
| | February | 11 | |
| | March | 5 | |
| | June | 12 | |
| | September | 10 | |
| | November | 9 | |
| | December | 6 | 57 |
| | Reinstated | | 1 |
| | | | 522 |

HONORARY MEMBERS

| | | | |
|---|---|---|---|
| January 1, 1902. | Honorary members | 4 | |
| | Addition | 1 | |
| | | — | 5 |

ASSOCIATES.

| | | | | |
|---|---|---|---|---|
| January 1, 1902. | Total associate membership | | 58 | |
| | Withdrawals: | | | |
| | Resignations | 3 | | |
| | Dropped | 3 | 6 | |
| | | — | — | |
| | | | 52 | |
| | Initiations: | | | |
| | January | 1 | | |
| | February | 1 | | |
| | September | 6 | 8 | 60 |
| | | — | — | — |
| January 1, 1903. | Total Membership | | | 587 |

SUMMARY OF RECEIPTS AND DISBURSEMENTS OF THE NEW ENGLAND WATER WORKS ASSOCIATION FOR THE YEAR 1902.

RECEIPTS.

| | |
|---|---|
| Dues | $2 406.85 |
| Advertising | 1 599.00 |
| June excursion | 346.00 |
| September excursion | 270.00 |
| Initiations | 223.00 |
| JOURNALS | 211.60 |
| Sundry | 32.30 |
| | $5 088.75 |

DISBURSEMENTS.

| | |
|---|---|
| JOURNAL | $1 661.69 |
| Rent | 400.00 |
| Stationery | 321.27 |
| Advertising Agent | 309.05 |
| Editor | 300.00 |
| Assistant Secretary | 300.00 |
| Incidental expenses | 249.06 |
| September excursion | 242.00 |
| June excursion | 241.00 |
| Secretary | 200.00 |
| Stenographer | 141.75 |

| | |
|---|---|
| Typewriting machine | $100.00 |
| Music | 56.00 |
| Cash | 50.00 |
| Stereopticon | 48.50 |
| Reprints | 43.00 |
| Transportation Agent | 17.00 |
| Total | $4 680.32 |

Amount of Receipts above expenditures ..... $408.43 *

At the present time there is due the Association:—

| | |
|---|---|
| For Dues | $592.10 |
| For Advertising | 662.50 |
| For Sundries | 19.53 |
| Total | $1 274.13 |

I know of no outstanding bills against the Association.

Respectfully submitted,

WILLARD KENT,

*Secretary.*

On motion of Mr. Coggeshall the report of the Secretary was accepted and placed on file.

* The larger figure given in the President's address includes interest on deposits, not received by the Secretary.

## REPORT OF THE TREASURER.

Mr. Lewis M. Bancroft, Treasurer, submitted the following report, which, having been duly audited, as shown by the report of the Finance Committee, was received, accepted, and placed on file, on motion of Mr. Stacy.

## LEWIS M. BANCROFT, Treasurer, *in account with* THE NEW ENGLAND WATER WORKS ASSOCIATION.

### RECEIPTS.

| | | | | |
|---|---|---|---|---|
| 1902. | | | | |
| Jan. | 1. | Balance on hand | | $2 063.57 |
| Aug. | 1. | Dividend, People's Savings Bank | | 51.76 |
| Dec. | 6. | " Mechanics' Savings Bank | | 17.42 |
| | | Interest, First National Bank | | .55 |
| Feb. | 26. | Received of Willard Kent, Sec'y, | $411.50 | |
| Mar. | 8. | " " " " " | 198.05 | |
| Apr. | 10. | " " " " " | 1 105.10 | |
| | 21. | " " " " " | 346.00 | |
| May | 3. | " " " " " | 149.05 | |
| | 22. | " " " " " | 106.75 | |
| July | 5. | " " " " " | 560.65 | |
| | 22. | " " " " " | 392.75 | |
| | 25. | " " " " " | 189.70 | |
| Sept. | 30. | " " " " " | 148.85 | |
| | | " " " " " | 270.00 | |
| Nov. | 11. | " " " " " | 609.75 | |
| | 26. | " " " " " | 161.60 | |
| Dec. | 25. | " " " " " | 322.75 | |
| 1903. | | | | |
| Jan. | 9. | " " " " " | 116.25 | 5 088.75 |
| | | | | $7 222.05 |

### EXPENDITURES.

| | | | |
|---|---|---|---|
| 1902. | | | |
| Feb. | 7. | D. Gillies' Sons, printing envelopes and notices | $55.60 |
| | | Samuel Usher, reprints | 17.00 |
| | | Hub Engraving Co., plates | 14.15 |
| | 10. | L. M. Bancroft, cash paid for printing check-book | 1.00 |
| | | Hobbs & Warren Co., cards and stationery | 2.90 |
| | | J. M. Ham, salary and expenses to February 1 | 39.78 |
| Mar. | 7. | Thomas P. Taylor, stereopticon, February meeting | 10.00 |
| | | Hub Engraving Co., plates | 4.15 |
| | | Geo. Lowell Tracy Music Library, music | 20.00 |
| | | D. Gillies' Sons, printing | 54.73 |
| | 10. | A. D. Handy, reading lamp | 6.00 |
| | | Boston Society of Civil Engineers, rent to March 1 | 100.00 |
| | | J. M. Ham, salary and expenses to March 1 | 36.38 |
| | 20. | Samuel Usher, printing March Journal | 276.67 |
| | | Charles W. Sherman, salary and expenses to April 1 | 83 63 |
| | | Elmwood Male Quartet, music | 16.00 |
| | 31. | Robert J. Thomas, advertising agent to April 1 | 75.55 |
| | | Thomas P. Taylor, stereopticon | 10.00 |
| Apr. | 7. | Bacon & Burpee, report of Jan., Feb., and March meetings | 37.25 |
| | | D. Gillies' Sons, printing postal cards | 13.75 |
| | | Willard Kent, salary and expenses to April 1 | 98.09 |
| | 12. | J. M. Ham, salary and expenses to April 1 | 27 60 |
| | 30. | W. N. Hughes, printing | 4.25 |
| May | 6. | J. M. Ham, salary and expenses to May 1 | 25.15 |
| | | Pratt Fastener Mfg. Co | 2.50 |
| | 10. | Samuel Usher, printing | 4.50 |
| | | Hub Engraving Co., plates | 25.91 |
| | | D. Gillies' Sons, due book | 7.85 |
| June | 6. | J. M. Ham, salary and expenses June 1 | 29.83 |
| | | Boston Society of Civil Engineers, rent to June 1 | 100.00 |
| | 14. | A. D. Handy, desk top | 2.50 |
| | 18. | Charles W. Sherman, salary and expenses to July 1 | 87.45 |
| | 24. | Robert J. Thomas, advertising agent to July 1 | 76 10 |
| July | 5. | Samuel Usher, printing June Journal | 251.75 |
| | | Hull and Boston Steamboat Co. | 150.00 |
| | | D. O. Wade, Nantasket Point dinners | 91 00 |
| | | The Somerville Journal Co., tickets for excursion | 1.75 |
| | | Willard Kent, salary to July 1 | 50 00 |
| | | J. M. Ham, salary and expenses to July 1 | 79.33 |
| | 24. | D. Gillies' Sons, printing | 37.25 |
| | | Hobbs & Warren Co., stationery | 2.25 |
| Aug. | 8. | Hub Engraving Co., plates | 51.06 |
| | 21. | N. E. Passenger Association | 17.60 |
| | 27. | D. Gillies' Sons, stamped envelopes | 11 85 |
| Sept. | 3. | J. M. Ham, salary and expenses to August 1 | 30.60 |
| | 9. | W. N. Hughes, envelopes for Journal | 15.50 |
| | 11. | J. M. Ham, salary and expenses to September 1 | 26.98 |
| | | C. A. Noyes & Co., door for case | 12.00 |
| | 22. | Charles W. Sherman, salary and expenses to October 1 | 46 75 |
| | | Samuel Usher, printing September Journal | 404.76 |
| | | Boston Society of Civil Engineers, rent to September 1 | 100 00 |
| | | The Brunswick, room for convention, board | 50.00 |

| | | | |
|---|---|---|---|
| Oct. | 3. | Somerville Journal Co., printing | $4.50 |
| | | W. N. Hughes, printing | 8.75 |
| | | J. E. Linnehan, Wayland Town Hall | 5.00 |
| | | H. A. Winship, trunk cover | 7.00 |
| | | Ross Bros., caterers | 125.00 |
| | | Thomas P. Taylor, stereopticon | 20.00 |
| | | Samuel Usher, printing | 22.00 |
| | | C. A. F. Emery & Son, printing | 12.00 |
| | | Chambers Printing Co., printing | 10.10 |
| | | The Whitehead & Hoag Co., badges | 28.00 |
| | 15. | D. Gillies' Sons, printing | 16.75 |
| | | Hub Engraving Co., plates | 7.72 |
| | | Willard Kent, salary and expenses to October 1 | 74.03 |
| | | Robert J. Thomas, advertising agent, to October 1 | 78.45 |
| | | Samuel Ward & Co., cash box | 2.50 |
| | 20. | Hobbs & Warren Co., record | 2.50 |
| | | W. T. Almy, badges | 22.00 |
| | | J. M. Ham, salary and expenses to October 1 | 27.66 |
| Nov. | 14. | C. A. Noyes & Co., hinge on door | 1.40 |
| | | Hub Engraving Co., plates | 32.08 |
| | | Bacon & Burpee, report of September meeting | 68.75 |
| | | D. Gillies' Sons, printing | 14.00 |
| | 28. | Antonio Amerina, music November meeting | 10.00 |
| | | J. M. Ham, salary and expenses to November 1 | 39.90 |
| | | Hub Engraving Co., plates | 4.69 |
| | | Samuel Usher, printing | 17.30 |
| | | E. L. D. Patterson, report of November meeting | 11.25 |
| Dec. | 9. | D. Gillies' Sons, printing | 4.50 |
| | | J. M. Ham, salary and expenses to December 1 | 30 61 |
| | 11. | J. M. Ham, salary and expenses to January 1, 1903 | 25 35 |
| | | Robert J. Thomas, salary and expenses to January 1, 1903 | 78.95 |
| | 20. | Amerina & Peters, music | 10.00 |
| | | H. A. Winship, canvas cover | 2 00 |
| | | Willard Kent, salary and expenses to January 1, 1903 | 73.40 |
| | 24. | Boston Society of Engineers, rent to December 1 | 100.00 |
| | | Charles W. Sherman, salary and expenses to January 1, 1903 | 87.52 |
| | | Hub Engraving Co., plates | 37.90 |
| | | Wyckoff, Seamans & Benedict, typewriter | 100.00 |
| | 26. | P. J. McAuliffe, barges | 112.00 |
| 1903. | | | |
| Jan. | 2. | Edgar D. Sewall, drawings | 39.25 |
| | 6. | Bacon & Burpee, reporting December meeting | 25.50 |
| | 8. | D. Gillies' Sons, printing | 12.10 |
| | 9. | Samuel Usher, printing December Journal | 432.95 |
| | | | $4 [illegible]2 |
| | | Deposit, People's Savings Bank, Worcester $1 345.18 | |
| | | Deposit, Mechanics' Savings Bank, Reading 1 011.42 | |
| | | Deposit, First National Bank, Reading 185.13 | |
| | | Balance on hand | 2 541.73 |
| | | | $7 222.05 |

LEWIS M. BANCROFT, *Treasurer.*

**Examined and found correct,**

**A. W. F. BROWN,**
**J. W. CRAWFORD,**
***Finance Committee.***

**January 14, 1903.**

## REPORT OF EDITOR OF THE JOURNAL.

Mr. Charles W. Sherman, Editor of the JOURNAL, submitted the following report: —

BOSTON, January 1, 1903.

*To the New England Water Works Association,* — The Editor of the JOURNAL presents the following as his report for the year 1902: —

The December issue of the JOURNAL contained thirty and one third pages of paid advertisements, of an annual value of $2 091. A year ago the Advertising Agent reported twenty-seven and one third pages of advertisements, worth $1 929 per year. The gain is best shown, however, by comparison with the number for December, 1900, which was the last issue preceding the election of an Advertising Agent; that issue contained but $1 145 worth of advertising in annual value.

Although a material gain in amount of advertising has been made, the receipts for the year from this source have been less than in 1901. The reason for this, and the consequent *apparently* bad financial report exhibited in Tables Nos. 2 and 3, following, is found in the late appearance of the December issue. Ordinarily it would have been out about December 1, but on account of the time required for computing tables of special castings, to accompany the Standard Specifications for Cast Iron Pipes and Special Castings, its appearance was delayed until December 29. This left too little time to send out bills for advertising and get any returns from them before the end of the year.

The accompanying tables show in detail the amount of material in the JOURNAL, the receipts and expenditures, and a comparison with the two preceding volumes.

Without crediting the JOURNAL with any part of the dues paid by members, it will be observed that the expenses incurred on account of the JOURNAL amount to $622.89 more than the receipts. This is due largely to the failure to send out during the year all the advertising bills properly belonging to 1902, as already explained. It is

also due in part to the unusually large expenses for drafting and engraving, in preparing tables to accompany the reports of the committee on pipe specifications, and in printing advance copies of these reports. It should be noted here that the expense to the Association would have been much greater had not the Metropolitan Water Works assumed the expense of computating the tables of spe-

TABLE No. 1. — STATEMENT OF MATERIAL IN VOLUME XVI, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1902.

| NUMBER. | DATE OF ISSUE. | NUMBER OF PAGES OF | | | | | | | | CUTS. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Papers. | Proceedings. | Total Text. | Index, etc. | Advertisements. | Covers and Contents. | Inset Plates. | Total. | |
| 1 | March . . . . . | 61 | 23 | 84 | . . . | 32 | 4 | 3 | 123 | 2 |
| 2 | June . . . . . | 79 | 3 | 82 | . . . | 32 | 4 | 4 | 122 | 8 |
| 3 | September . . . . . | 77 | 5 | 82 | . . . | 34 | 4 | 8 | 128 | 9 |
| 4 | December . . . . . | 135 | 20 | 155 | 10 | 34 | 4 | 8 | 211 | 22 |
| | Total . . . . . | 352 | 51 | 403 | 10 | 132 | 16 | 23 | 584 | 41 |

TABLE No. 2. — RECEIPTS AND EXPENDITURES ON ACCOUNT OF VOLUME XVI, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION, 1902.

| RECEIPTS. | | EXPENDITURES. | |
|---|---|---|---|
| From Advertisements . . | $1 599.00 | For Printing Journal . . | $1 297.63 |
| „ Sale of Journals . . | 90.60 | „ Preparing Illustrations | 232.21 |
| „ Sale of Reprints . . | 5.50 | „ Editor's Salary . . . | 300.00 |
| „ Sale of Cuts . . . | 1.00 | „ Editor's Incidentals . | 34.55 |
| „ Subscriptions . . . | 121.00 | „ Advertising Commmissions . . . . . | 309.05 |
| | $1 817.10 | „ Reporting . . . . . | 141.75 |
| | | „ Reprints and Advance Copies . . . . . | 107.50 |
| Excess of Expenditures . | 622.89 | „ Statistics Forms . . . | 17.30 |
| | $2 439.99 | | $2 439.99 |

TABLE No. 3. — COMPARISON BETWEEN VOLUMES XIV, XV (4 NUMBERS), AND XVI, JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION.

| | *Vol. XIV.* | *4 numbers of Vol. XV.* | *Vol. XVI.* |
|---|---|---|---|
| Edition (copies) | 1 100 | 1 200 | 1 200 |
| Average membership | 601 | 586 | 571 |
| Pages of text | 345 | 363 | 403 |
| Pages of text per 1 000 members | 600 | 618 | 707 |
| Total pages, all kinds | 485 | 536 | 584 |
| Total pages per 1 000 members | 832 | 913 | 1 020 |
| GROSS COST: | | | |
| Total | $1 954.15 | $2 194.26 | $2 439.99 |
| Per page | 4.03 | 4.10 | 4.18 |
| Per member | 3.35 | 3.75 | 4.27 |
| Per member per 1 000 pages | 6.91 | 6.99 | 7.32 |
| Per member per 1 000 pages of text | 9.71 | 10.31 | 10.60 |
| NET COST: | | | |
| Total | $347.55 | $332.90 | $622.89 |
| Per page | .72 | .62 | 1.07 |
| Per member | .60 | .57 | 1.09 |
| Per member 1 000 pages | 1.23 | 1.06 | 1.87 |
| Per member per 1 000 pages of text | 1.73 | 1.57 | 2.71 |

cial castings, in order to have them more immediately available for their own use. This was done through the coöperation of our members, Frederic P. Stearns, Chief Engineer, and Dexter Brackett, Engineer of the Distribution Department of the Metropolitan Water Works.

The usual fifty reprints of papers have been furnished to their authors without charge. Two hundred reprints of the preliminary report of the committee on pipe specifications were printed as an aid to the committee. The net cost to the Association of these reprints has averaged $6.30 for each paper reprinted.

The total cost of illustrations for this volume has been $335.71, or 13.7 per cent. of the gross cost of the JOURNAL. This percentage is large, but results principally from drafting and engraving tables for the pipe specifications.

The present circulation of the JOURNAL is: —

| | |
|---|---|
| Members (all grades) | 587 |
| Subscribers | 40 |

Exchanges are made with twenty-one periodicals.

The custom of sending out three hundred sample copies of each issue has been continued. Originally one number of each volume was sent to every water works in this country and Canada, but a few years ago, in order to comply with new rulings of the Postoffice Department, the present method was adopted. Under this arrangement a copy is sent to every water works in the United States and Canada about once in eighteen months. These sample copies do not seem to result in benefit to the Association at all commensurate with their cost, and it is doubtful whether the advertisers reap any return from this attempt to extend the circulation.

The reprints from the December number of the JOURNAL are not yet ready. The Standard Specifications for Cast-iron Pipe and Special Castings are also being reprinted in pamphlet form; it is the intention to supply whatever demand there may be for these specifications at cost. This work is not yet completed, and of course the bills for it have not yet been presented. A general index to the JOURNAL, from the first number, is now being prepared on cards by the Library Bureau. This card index will be kept at headquarters, and will be kept up to date. It is also the intention to print the index in pamphlet form for distribution to the members.

With the exception of the unfinished work just mentioned, for which bills have not been rendered, I know of no unpaid accounts against the Association on account of the JOURNAL.

Respectfully submitted,

CHARLES W. SHERMAN,
*Editor.*

On motion of Mr. Holden the report of the Editor was received, accepted, and placed on file.

Mr. A. F. W. Brown, on behalf of the Finance Committee, reported that the committee had examined the accounts of the Secretary and of the Treasurer, and found them correct, correctly footed, and with the proper vouchers.

On motion of Mr. Fuller the report of the Finance Committee was accepted.

THE PRESIDENT. We are honored this afternoon by the presence with us, as our guest, of the chief executive of one of the leading cities of the Commonwealth, and I have the pleasure of introducing

to you at this time his Honor Mayor Grant, of Lawrence. [Applause.]

Hon. Alexander L. Grant. Mr. President and members of the Association, if there is anything I did not expect this afternoon, it was that I should be called upon to make a speech. I am rather young in municipal management, and I cannot tell you gentlemen much about water works or the water department. It seems to me that a great deal of good must come from these meetings and from the exchanging of views and ideas here. I am a student in my city, but I believe that one of the most important departments in the city is its water department and that there are few things more important for the health of the city than a supply of pure water. We have a filtering system that we are told is a fine one, but the capacity of the present filter is not sufficient, as I am informed, and we are now taking up the matter and are going to try to increase its capacity, and I think we can do it under the efficient lead of our water board. I know little or nothing about water-works matters, but I am going to try and learn, and I am going to come down here once in a while, if my friends are good enough to invite me, to meet with you. I am glad to be here this afternoon; I have enjoyed myself very much, and I wish I were better able to talk to you on the subject of water supply. I thank you, gentlemen. [Applause.]

The first paper for the afternoon was by E. H. Gowing, Civil Engineer, Boston, entitled "How I Reduce Pressure on a Gravity System." The subject was discussed by Freeman C. Coffin, Frank L. Fuller, J. Waldo Smith, Edwin C. Brooks, and Dexter Brackett.

## ELECTION OF OFFICERS.

Mr. George E. Winslow submitted the following report of the Tellers appointed to canvass ballots for officers for the ensuing year: —

Total number of ballots, 207.

*For President.*

CHARLES K. WALKER, Manchester, N. H., 203.

*For Vice-Presidents.*

V. C. HASTINGS, Concord, N. H., 197.
GEORGE P. WESCOTT, Portland, Me., 193.
EDWIN C. BROOKS, Cambridge, Mass., 199.
E. W. KENT, Woonsocket, R. I., 194.
H. N. TURNER, St. Johnsbury, Vt., 193.
J. C. HAMMOND, Jr., Rockville, Conn., 196.

*For Secretary.*

WILLARD KENT, Narragansett Pier, R. I., 200.

*For Treasurer.*

L. M. BANCROFT, Reading, Mass., 200.

*For Editor.*

CHARLES W. SHERMAN, Boston, Mass., 203.

*For Advertising Agent.*

ROBERT J. THOMAS, Lowell, Mass., 203.

*For Additional Members of Executive Committee.*

P. KIERAN, Fall River, Mass., 203.
GEORGE A. STACY, Marlboro, Mass., 202.
H. G. HOLDEN, Nashua, N. H., 202.

*For Finance Committee.*

E. J. CHADBOURNE, Wakefield, Mass., 202.
W. F. CODD, Nantucket, Mass., 203.
A. R. HATHAWAY, Springfield, Mass., 204.

These gentlemen were declared elected. The retiring President, Mr. Merrill, in calling the newly elected President to the chair, spoke as follows: —

Your President-elect needs no introduction to you, gentlemen. He has been in and out of these meetings for many years and has regaled us with his wit and his wisdom so many times that it would be out of place for me to presume to introduce him to you. He was one of those twenty-one men who assembled in a neighboring hotel on the 19th of April, 1882, and on June 21st of that year he assisted in founding the New England Water Works Association. I am sure that he would have filled the office to which he has just been elected many years ago, had it not been for the characteristic New Hampshire modesty which has always been so becoming to him. [Laughter.] I congratulate the Association upon having finally landed him [applause]; and I congratulate you, Mr. President, upon entering upon the duties of your office under such favoring auspices. Gentlemen, I now have the pleasure of presenting to you your President, Charles K. Walker. [Applause.]

President Walker on taking the chair spoke as follows: —

*Gentlemen*, — I feel very grateful and very thankful for the honor you have conferred upon me. I tell you that I appreciate it, because I know most of the members of this Association, although I do not know them all by name; their faces are familiar to me, and I have shaken hands with them. I am very glad to accept this position to which you have elected me, but still I accept it very reluctantly, because you have had presidents in the past who know as much again as I do, men of ability, — smart men. But I suppose I have been elected because I am an old fellow, about ready to step down and out. [Cries of "No! No!"] I will tell you just exactly how I came to consent to take the nomination. I saw Mr. Hastings, of Concord, coming to my office one day, as I looked out of the window, and I said to myself, "What in the dickens is Hastings doing down here?" He came into the office and I said, "Is there anything I can do for you?" Said he, "I am going to sit right down here with you and stay here until you accept the nomination for President of our Association." Said I, "You will have a long time to stay, then, for I shall not consent." Said he, "It 's an honor for a man to be President of this Association." I said, "I know that, but I prefer to be the chaplain. I want to be chaplain long enough to bury some of my insurance friends." [Laughter.] I told him I was too old a man, there was no mistake about it; that I could n't bear the burdens of the office, but he replied, "Why, you are younger than a good

many of those fellows down there who are only forty." Well, that kind of broke me down, and I finally consented.

You must bear with me a little, for I have got to have some help in this business; and I know there are some folks right around me now who are ready to help me. We have among our members some of the smartest men in America, some of the best engineers; and here am I, not an engineer and not much of anything else, so, as I said, it is very reluctantly that I accept the presidency of the Association.

Mr. Leonard Metcalf, of Boston, read a paper, illustrated by the stereopticon, descriptive of the Echo Lake Dam at Milford, Mass.

The President next called upon Mr. F. H. Crandall, Chairman of the Committee on "Apportionment of Charges for Private Fire Protection and the Means of Controlling the Supply thereto," for a report.

Mr. Crandall. The committee did not expect to be called upon to report at this time. We understand that we were appointed for the purpose of conferring with committees which might be appointed from other associations interested in this same matter, and we have as yet had no opportunity to do that. It will take considerable time for the appointment of these other committees and to arrange for taking the matter up with them. We have not yet received the reprints of the report of the former committee, which we would like to have for use in our work. We have, therefore, simply to report that we have met, and I think we are favorably impressed with each other.

Adjourned.

# PROCEEDINGS.

## February Meeting.

Hotel Brunswick,
Boston, February 11, 1903.

President Charles K. Walker in the chair; Willard Kent, Secretary.

The following members and guests were in attendance: —

### Members.

S. A. Agnew, C. H. Baldwin, L. M. Bancroft, J. E. Beals, J. W. Blackmer, George Bowers, Dexter Brackett, E. C. Brooks, Fred Brooks, G. A. P. Bucknam, G. F. Chace, E. J. Chadbourne, J. C. Chase, R. L. Cochran, M. F. Collins, H. A. Cook, G. K. Crandall, Lucas Cushing, L. E. Daboll, L. N. Farnum, B. R. Felton, A. P. Folwell, F. F. Forbes, W. E. Foss, A. D. Fuller, J. C. Gilbert, A. S. Glover, F. W. Gow, J. O. Hall, D. A. Harris, L. M. Hastings, T. G. Hazard, Jr., H. G. Holden, H. R. Johnson, D. A. Heffernan, E. W. Kent, Willard Kent, G. A. Kimball, C. F. Knowlton, D. A. Makepeace, A. E. Martin, F. E. Merrill, H. A. Miller, F. L. Northrop, C. E. Riley, W. W. Robertson, C. M. Saville, W. T. Sedgwick, C. W. Sherman, G. T. Staples, G. A. Sanborn, G. H. Snell, G. A. Stacy, L. A. Taylor, R. J. Thomas, H. L. Thomas, D. N. Tower, W. H. Vaughn, C. K. Walker, R. S. Weston, G. E. Wilde, F. B. Wilkins, C.-E. A. Winslow, G. E. Winslow. — 64.

### Honorary Member.

F. W. Shepperd. — 1.

### Associates.

Ashton Valve Mfg. Co., by C. W. Houghton; Harold L. Bond & Co., by George S. Hedge; Builders Iron Foundry, by F. N. Conne; Chapman Valve Mfg. Co., by E. F. Hughes; Hersey Mfg. Co., by Albert S. Glover and Walter Hersey; Lamb & Ritchie, by Harry F. Peck; Lead Lined Iron Pipe Co., by T. E. Dwyer; Ludlow Valve Mfg. Co., by H. F. Gould; Nationa Meter Co., by Charles H. Baldwin and J. G. Lufkin; Neptune Meter Co., by H. H. Kinsey; Perrin, Seamans & Co., by Charles E. Godfrey; Rensselaer Mfg. Co., by F. S. Bates; A. P. Smith Mfg. Co., by M. G. Millikin and D. F. O'Brien; Union Water Meter Co., by F. L. Northrop. — 17.

### Guests.

J. P. Wood, Marlboro, Mass.; H. J. Cornegan, General Freight Agent Boston & Philadelphia Steamship Co., Boston, Mass.; Mayor E. S. Horton

and E. B. Hill, Attleboro, Mass.; Mr. Burke, Water Commissioner, Brookline, Mass.; Mr. Donovan and A. H. Robinson, Lawrence, Mass.; John H. Cook, Paterson, N. J.; J. F. Gleason, Quincy, Mass.; J. E. Bunting, H. F. Snow, and J. F. Mallory, Boston, Mass. — 12.

(Names counted twice — 3.)

The Secretary read the following names of applicants for membership, the applications having been approved by the Executive Committee: —

*For Resident Members.*

Samuel H. McKenzie, Southington, Conn., Superintendent Southington Water Co.; Arthur Truman Safford, Lowell, Mass., Civil and Hydraulic Engineer; Earle B. Phelps, Lawrence, Mass., engaged in the study of filtration of water and sewage and chemical and bacteriological examination of same.

*For Non-Resident Members.*

Morrell Vrooman, Gloversville, N. Y., City Engineer of Gloversville; George Goodell Earl, New Orleans, La., General Superintendent New Orleans Sewerage and Water Board.

On motion of Mr. Thomas, of Lowell, the Secretary was instructed to cast the ballot of the Association in favor of the applicants; they were declared elected as members.

Mr. Robert Spurr Weston, Chemist and Bacteriologist, Boston, read a paper, illustrated by the stereopticon, on "The Water Supply of New Orleans, La., and its Improvement." Mr. C.-E. A. Winslow, of Boston, and Mr. M. F. Collins, of Lawrence, spoke on topics suggested by the paper.

Mr. Caleb Mills Saville, Division Engineer, Boston, read a paper, illustrated by stereopticon views, on "Pipes and Pipe Laying of the Metropolitan Water Works." Mr. Horace G. Holden, Mr. Dexter Brackett, Mr. George E. Winslow, Mr. Robert L. Cochran, Mr. Frank E. Merrill, and Mr. John H. Cook participated in the discussion which followed the reading of the paper.

The President announced that Past-Presidents Holden and Merrill had been appointed a committee to consider and report upon the place for holding the annual convention in September, and that they would be glad to receive suggestions from any of the members.

Adjourned.

## EXECUTIVE COMMITTEE.

The Executive Committee met at headquarters, Tremont Temple, on Wednesday, January 14, 1903, at 11.30 A.M. Present: President F. E. Merrill, Secretary Willard Kent, and Messrs. L. M. Bancroft, C. W. Sherman, E. C. Brooks, C. K. Walker, H. G. Holden, G. A. Stacy, and J. C. Hammond, Jr. Seven applications for membership were approved for recommendation to the Association.

---

February 11, 1903. — The following were present: President C. K. Walker, Secretary Willard Kent, and Messrs. E. C. Brooks, Edmund W. Kent, George A. Stacy, H. G. Holden, L. M. Bancroft, C. W. Sherman, and R. J. Thomas.

Five applications for membership were considered, and it was voted to recommend them to the Association for ballot.

Past Presidents H. G. Holden and Frank E. Merrill were appointed a committee to investigate and report to the Executive Committee at its next meeting, on a place for holding the next annual convention.

A proposed circular letter, to be sent out with sample copies of the Standard Specifications for Cast-iron Pipes and Special Castings, was read and endorsed.

## OBITUARY.

Cyrus B. Martin, Treasurer of the Norwich Water Works Company, died at his home in Norwich, N. Y., on April 2, 1902, after a short illness.

Mr. Martin was born in Argyle, N. Y., on September 6, 1830. After attending the academy in that town, he learned the printer's trade, and in 1855 went to Norwich and became joint editor and part owner of the Chenango *Telegraph*. In 1861 he removed to Newburgh, N. Y., where he conducted the Newburgh *Journal* until 1877, when he returned to Norwich. He was president of the Chenango National Bank and of the David Maydole Hammer Company, and director in several other corporations.

He was married in 1858 to Ann Vernette Maydole, of Norwich, who died in 1885. He is survived by three daughters.

Mr. Martin was elected a member of the New England Water Works Association on June 17, 1887.

## BOOK NOTICE.

**"Ancient and Modern Engineering and the Isthmian Canal." By William H. Burr, C.E., Professor of Civil Engineering in Columbia University. 8vo. xv + 473 pages. Profusely illustrated. New York: John Wiley & Sons. $3.50 net.**

**This book is the outgrowth of a series of lectures delivered by the author. It is an admirable review of engineering in general, and gives, in addition to historical notes, a *résumé* of the present best practice in all branches of civil engineering. Part III, devoted to water works, covers 140 pages, into which a very good treatment of the subject has been condensed. The part devoted to the Isthmian Canal is worthy of especial mention, because of the general interest in the subject, and because Professor Burr was a member of the Isthmian Canal Commission.**

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# THE "AA" EMPIRE WATER METER

IS RECEIVING THE HIGHEST COMMENDATION IN ALL SECTIONS OF THE COUNTRY

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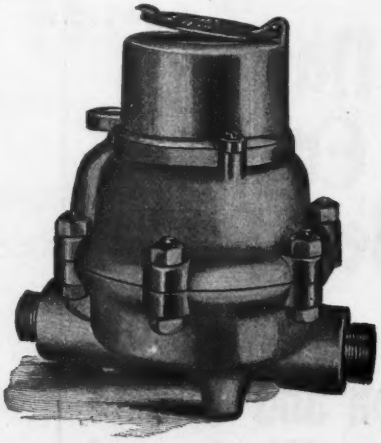

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# HERSEY ROTARY METER

# HERSEY TORRENT METER

The above are trade names given to the WATER METERS of our manufacture.

A full description of each type can be found in our illustrated catalog, which we would be glad to supply you if you are interested.

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Over 1100 cities and towns using our meters.

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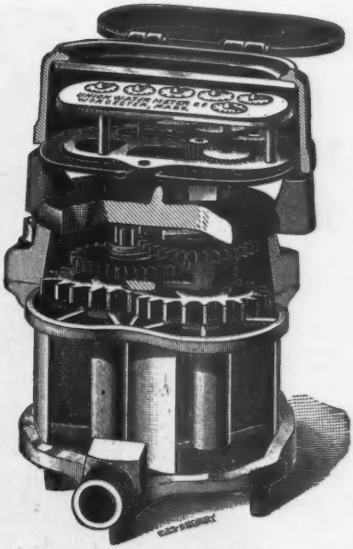
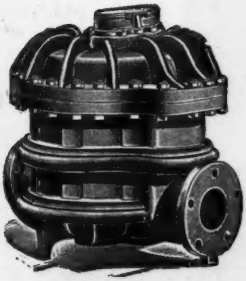


*Showing 58-inch Union Rotary Piston Meter.*



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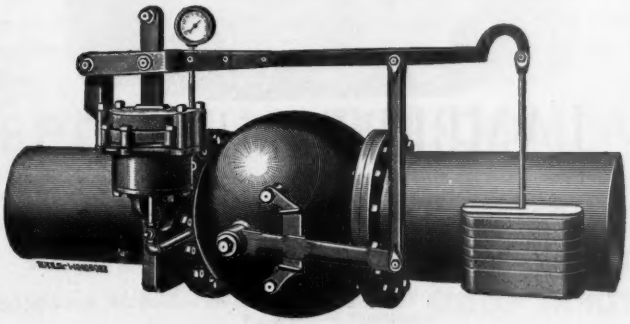

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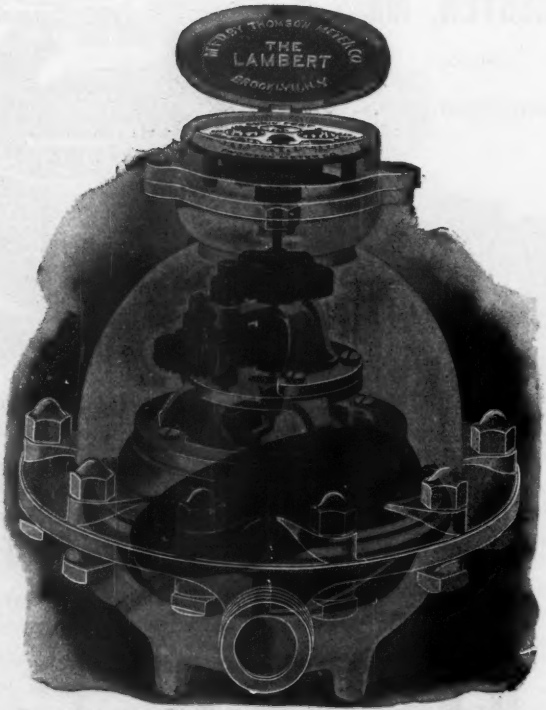


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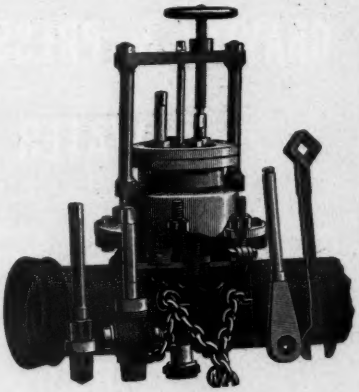

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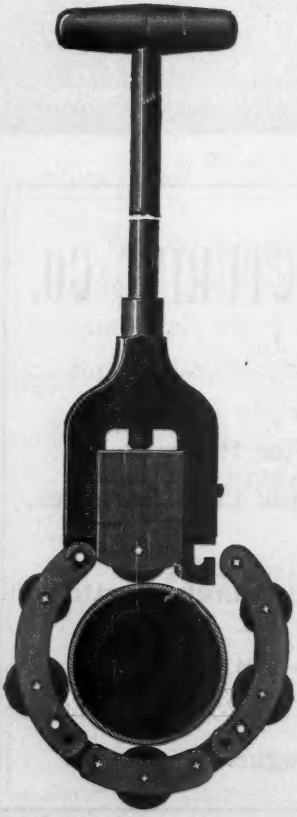

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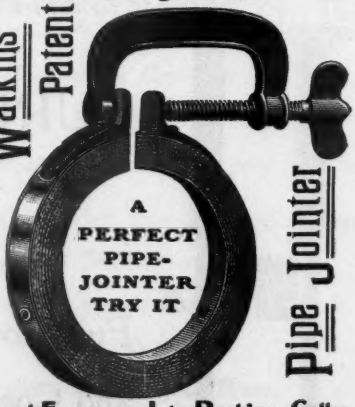


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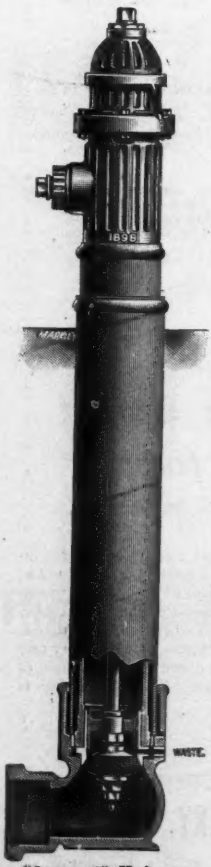


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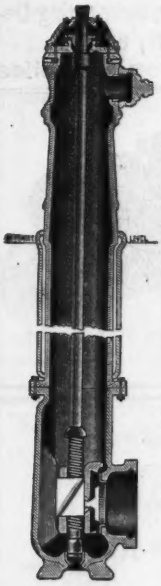

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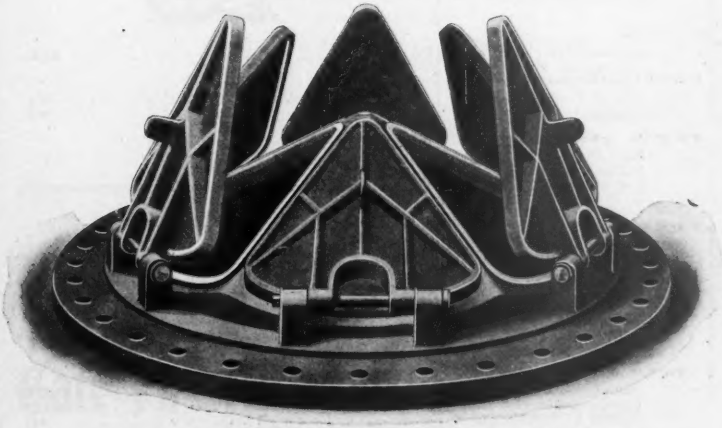

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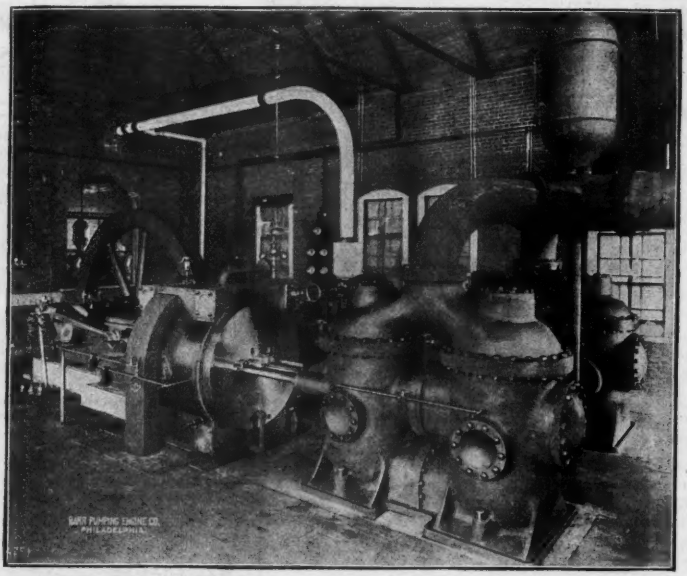

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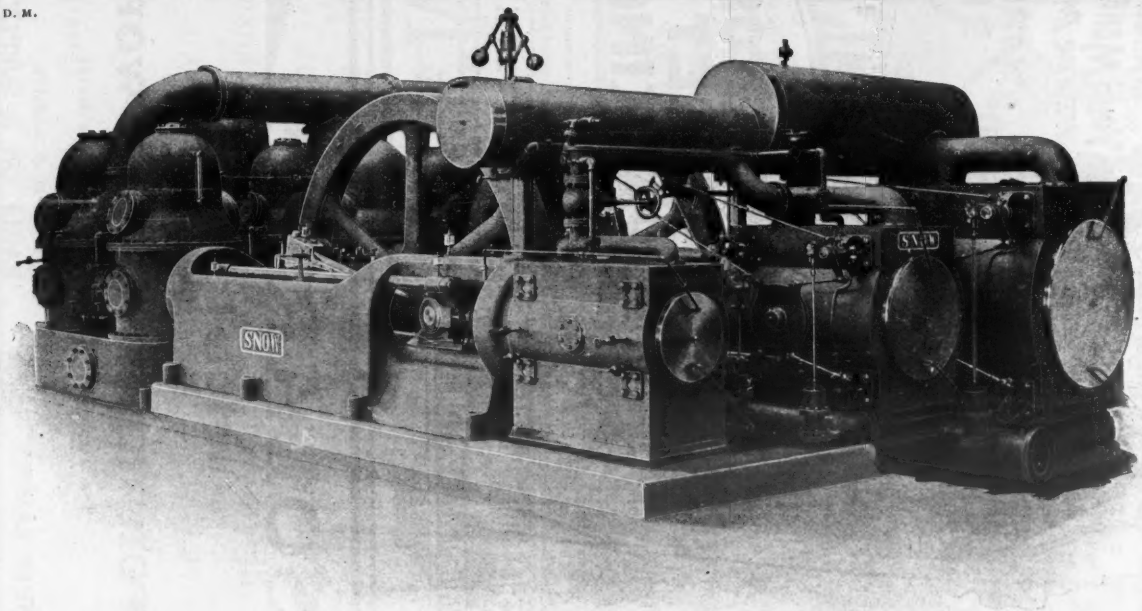
M. J. S. D.

# The Snow Steam Pump Works, BUFFALO, N. Y.

J. S. D. M.




Standard Type Horizontal Triple Expansion Crank and Fly-Wheel High Duty Pumping Engine.

Designed and built exclusively by The Snow Steam Pump Works.

THE MAN WHO WHISPERS VERY LOW
ABOUT THE GOODS HE HAS TO SHOW
CAN'T SAVE HIS CUSTOMERS THE DOLLARS
LIKE ONE WHO CLIMBS A TREE AND HOLLERS
WE GUARANTEE SATISFACTION OR YOUR MONEY BACK
WRITE FOR PRICES
OUR GOODS ARE RIGHT
TRADE
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ASBESTOS SHEET PACKING
ESPECIALLY ADAPTED FOR HIGH PRESSURES
EAGLE OIL AND SUPPLY CO
104
BROAD ST BOSTON MASS

We use the best grade of Asbestos and we make the Best Sheet Packing that can be made.

It is used and endorsed by the leading Engine Builders of this country. If you have a bad joint try Eagleine Asbestos upon it, it holds where others fail and enables you to break joints and replace the same packing.

If it does not do exactly what we say it will, your money back for the asking. It costs you nothing to try it as we assume the risk.

Price, 60c. per pound.

Information and Booklet sent on request.

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## Metal Polish

*Liquid and Paste form*

## FOR HOT AND COLD WORK

*The Quickest Working Brass Polish on the Market*

FREE SAMPLE.

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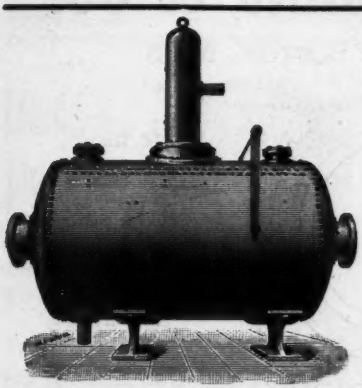

SAND AND AIR SEPARATOR. Pat. No 545,026.

WE have had twenty-five years' experience in supplying cities and towns and large corporations by the artesian and driven well system. We have also driven many thousand wells for domestic purposes.

Our experience enables us to locate with a great degree of accuracy the most favorable places for obtaining water.

We have patented and manufacture a Sand and Air Separator, capable of taking care of from one to eight million gallons of water per day. It prevents the sand from rising to the pump. No driven well system is complete without one. Send for description and price.

*We refer by permission to*

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# GRAPHITE ELASTIC PAINT

REGISTERED IN U.S. PATENT OFFICE, JULY 16TH 1901

FOR METAL ROOFS, TANKS, FENCES ETC.

STOPS LEAKS AND PREVENTS RUST.

MADE ONLY BY

THE NATIONAL PAINT AND VARNISH CO.

CLEVELAND, OHIO.

S. D. M. J.

OFFICE OF
THE WATER BOARD.

WINCHESTER, MASS.,
January 20, 1902.

The National Paint and Varnish Co.,
Cleveland, Ohio.

GENTLEMEN:

After using your Graphite Elastic Paint for a period of between two and three years, I write to say that it has given the very highest satisfaction. Indeed, I feel that I cannot recommend it too strongly. My own experience convinces me that for the uses to which it is applied, Graphite Elastic Paint has no equal in the market. One year ago it became necessary to paint the inside of our standpipe, used in connection with the town water supply. I was advised to use asphaltum; but my own judgment led me to prefer your paint. I tried both, however, to meet both views. The standpipe was painted inside with your Graphite Elastic Paint, with the exception of one lap upon which a lining was made of the best quality of asphaltum.

Recently, upon drawing off the water and making a thorough examination, it was discovered that whereas the asphaltum had entirely disappeared, leaving in its stead a thick coating of rust, the Graphite Elastic Paint was in a perfect state of preservation and not harmed, save where the ice forming on the surface of the water had left scars, as would have happened to any substance.

I have never seen as good a substance for such a purpose, and should never use a substitute as long as I could procure your paint.

Yours very truly,

W. T. DOTTEN,
*Superintendent Water Works,*
Winchester, Mass.

# THE GOULD PACKING CO.

**Gould's Packing**

Trade Mark.

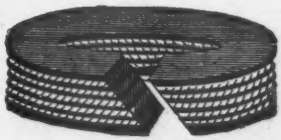
If you want the best, get

**Gould's Steam and Water Packing ....**

The original ring packing

Buyers will see that our name, Gould's Steam and Water Packing, and our Trade Mark are stamped on every package. *Unless so stamped they are imitations.*

In ordering be careful to give the EXACT diameter of stuffing-box and of piston-rod or valve-stem.



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HIGH PRESSURE

WATERPROOF HYDRAULIC

**GARLOCK HIGH PRESSURE RING** is made especially for high steam pressures. The rubber cushion is on the **INSIDE**, and can't be damaged by oil or intense heat — the fibrous matter is absolutely **HEAT PROOF**. It positively cannot bake, vulcanize or "burn out"; it must **WEAR** out. It gives from four to six times the service of any other fibrous steam packing.

**WE GUARANTEE THAT IT WILL EASILY OUTWEAR ALL OTHERS, OR WILL COST YOU NOTHING**

**GARLOCK WATERPROOF HYDRAULIC** is positively without an equal for cold water. It is used by the U. S. Government on the disappearing gun carriages of all coast fortifications, and against hydraulic pressures of from 1000 to 2500 pounds per square inch. Used by City of New York, Boston, Lowell, Lawrence, and most of the large pumping stations in this country. It will easily outwear any others on cold-water plungers and rods.

**OUR OFFER** is to make you up a set of either of these, and if not the best you've ever used, we won't charge you a cent. You can be the judge.

**CAN'T YOU GIVE US A TRIAL?**

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**All kinds of Packings and Engineers' Supplies**

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## "COMBINATION" HYDRAULIC AND STEAM PACKING

is especially adapted to the requirements of

**PUMPING STATIONS**

as it is not only EXCELLENT for Steam but is POSITIVELY the BEST Hydraulic Packing made.

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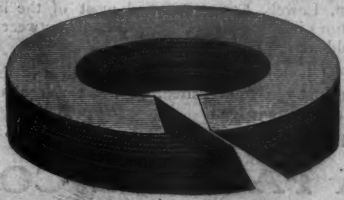
## CHESTERTON'S "EXPANSION RING" PACKING



has the gum (used to give expansion to Packings) in the CENTRE, where it is not affected by STEAM or OIL, both of which tend to destroy its life. The rubber is grooved out so as not to touch the rod, and this groove makes an EXCELLENT RESERVOIR for OIL, which helps to keep the rod cool.

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